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PAPERS AND PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

TASMANIA,

FOR

1892.

(ISSUED JUNE, 1893.)

TASMANIA:
PRINTED AT "THE MERCURY" OFFICE, MACQUARIE ST., HOBART.

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Contents.

Page
April Meeting I
Handbook of the Botany of Tasmania I
Geology of Tasmania II
Tasmanian Apples in London (a Paper) II
List of the Known Lichens in Tasmania (a Paper)... VI
Tasmanian Spiders (a Paper)... VI
May Meeting VI
Science Congress VI
Ardea pacifica VI
Herodias alba VI
Erismatura australis (first time recorded in Tasmania) VI
Australian Coot VI
Export of Apples VII
The Climate of Tasmania indicated by its Lichen Flora (a Paper) VIII
Correspondence *re* Mutton Birds (Col. Legge) IX
Presentation of Tasmanian Mosses (by Mr. W. A. Weymouth) ... X
Presentation of Tasmanian Lichens (Rev. R. M. Wilson) X
Rocks (Calcite and Limestone) X
Infusorial earth XI
Estoniella rufilabris (a Paper) XI
June Meeting XI
Election of Mr. Chas. Holdsworth XI
A.A.A.S. Journal XI
Notes on Natural Limits to Occupation on the Land (a Paper) ... XI
Notes on Square-set System of Timbering in Mines, etc. (a Paper) XI
July Meeting XI
Plants New to Tasmania (a Paper) XII
Artificial Obstructions to Occupation of the Land (a Paper) ... XII
On the Occurrence of Some Australian Ardeidæ (a Paper) ... XII
August Meeting XII
Letter from Mr. H. C. Russell XII
The Leake School of Practical Astronomy (a Paper) XII
Rev. Geo. Clarke's remarks XIII
Mr. G. W. Waterhouse's letter XIV
Resolution proposed *re* Leake bequest XV
Sir Lambert Dobson's remarks XV
Mr. T. Stephens' remarks XV

Mr. J. B. Walker's remarks ... xv
Rev. Dr. Scott's remarks ... xv
Mr. H. C. Kingsmill's remarks ... xv
Hon. N. J. Brown's remarks ... xv
Remarks on Sir Robert Ball's Paper (a Paper) ... xvi
Plate of Actinoceras ... xvii
The Astronomical Explanation of a Glacial Period ... xvii
Orthoceraite Specimen, exhibited by Mr. Stephens ... xvii
Tasmanian Mosses, presentation by Mr. W. A. Weymouth ... xvii
September Meeting ... xviii
Representation of the People (a Paper) ... xviii
Tasmanian Insects (a Paper) ... xviii
November Meeting ... xviii
Elgin Marbles (a Paper) ... xviii
Note on the Voracity of the Kelp Fish (a Paper) ... xviii
Note on the Tasmanian Acanthiza (a Paper) ... xviii
Study of Natural History in Tasmania (a Paper) ... xix
Notes on Tasmanian Crustacean (a Paper) ... xix
Notes on Plants New to Tasmania (a Paper) ... xix
Presentation to His Excellency and Lady Hamilton ... xix
Farewell Meeting of His Excellency the President ... xix
The President's Reply ... xix
Lady Hamilton's Reply ... xx
The Souvenirs ... xx
The President's Farewell Address ... xx
List of Additions to the Library ... xxvii
List of Works Purchased for the Morton Allport Library ... xxxii

CORRIGENDA.

Page 79—On the Occurrence of Some Australian Arcleidæ in Tasmania read "Ardeidæ," also on page 80.

PAPERS.

Page

ART. I.—Tasmanian Apples in London. By W. E. Shoobridge... ii

ART. II.—Notes on the Natural Limits to Occupation of the Land. By R. M. Johnston, F.L.S. 1

ART. III.—What are the Conditions which Determine the Just and Equitable Representation of the People. (Diagram.) By R. M. Johnston, F.L.S. 9

ART IV.—Remarks on Sir Robert Ball's Paper (read at the Hobart Meeting of the A.A.A.S.), entitled "The Astronomical Explanation of a Glacial Period... 21

ART. IV.—On the Proposed Leake School of Practical Astronomy 26

ART. V.—Trade Unionism as a Factor in Social Evolution. By A. J. Taylor, F.L.S. 32

ART. VI.—Notes on Tasmanian Crustacea, with Descriptions of New Species. (Plates.) By G. M. Thomson, F.L.S. .. 45

ART. VII.—Note on a Tasmanian Acanthiza. By Col. W. V. Legge, F.Z.S. 77

ART. VIII.—On the Occurrence of some Australian Ardeidæ in Tasmania. By Col. W. V. Legge, F.Z.S. 79

ART. IX.—Additions to Tasmanian Flora. II. By Leonard Rodway 82

ART. X.—"The Use of the Womerah, or Throw Stick," by the Aborigines of Tasmania. By A. J. Taylor, F.L.S .. 84

ART. XI. - Concerning various means of Encouraging the Study of Natural History in Tasmania. By J. R. McClymont, M.A. 85

ART. XII.—On the Classification, Position, and Synonyms of Eatoniella rufilabris. By Professor R. Tate, F.G.S. ... 88

ART. XIII.—Notes on some Plants new to Tasmania. By Leonard Rodway 92

ART. XIV.—On new Species of Tasmanian Araneæ. By A. J. Urquhart 94

ART. XV.—Notes on the use of the Square-set System of Timbering in Mines at Zeehan and Dundas. (Title.) By A. J. Taylor, F.L.S. 130

ART. XVI.—Elgin Marbles. (Title.) By Montague Rhys-Jones, C.E. 130

ART. XVII.—Notes on some Tasmanian Insects. (Title.) By A. Morton, F.L.S. 130

ART. XVIII.—The Climate of Eastern Tasmania, indicated by its Lichen Flora. By Rev. F. R. M. Wilson 131

ART. XIX.—A List of the known Lichens of Tasmania. By J. Shirley, B.Sc. 179

ROYAL SOCIETY.

APRIL, 1892.

The first monthly evening meeting of the session of the Royal Society was held at the Museum on Tuesday, April 12. Mr. C. H. Grant presided. An apology for absence was received from His Excellency the Governor, Sir R. G. C. Hamilton, K.C.B., LL.D., President of the Society.

NEW MEMBER.

The Secretary (Mr. Alex. Morton) introduced a new member of the Society, Mr. John Goodall, civil engineer.

BOTANY OF TASMANIA.

The Secretary said that Mr. Leonard Rodway was preparing a "Handbook of the Botany of Tasmania," which he wished to bring out under the auspices of the Society. Mr. Rodway was present, and would explain the purport of his work.

Mr. **Rodway** said they had never possessed in Tasmania a really complete handbook of the flora of the colony. They had Hooker's work, certainly, but it was too expensive for the ordinary public. The only other work was one including the whole of the flora of Australia, which had the same drawback. The late Mr. Spicer brought out a handbook, but it was really little else than a key to the works mentioned, and was now out of print. It was so painfully artificial that in order to work a plant out by it the student must be possessed of the first-mentioned publications. When he first took up botany here he found there was a necessity for a handbook; and on mentioning the fact that he was thinking of compiling one during the meetings of the Australian Association for the Advancement of Science several members urged him to go on with it at once. He had prepared a certain portion of the work, an eighth or tenth portion of the whole manuscript. In what he had prepared there were 190 species dealt with, which was about one-fifth of the whole in Tasmania. The plan of the work was similar to that adopted by Bentham in the "Flora of the British Isles." The work would be divided into two volumes, and in the event of the Society taking it up, the first volume could be published in twelve months, and the second two years thereafter. He had done all he could to avoid technicalities in preparing the work. What he would suggest was that the Council of the Society would look over the portion he had drawn up, and tell him whether, provided he produced the manuscript according to their suggestions and their satisfaction, they would support its publication.

The **Chairman** said he had no doubt the Council would be willing to assist in anything of that kind. He thought it would be a waste of labour, however, to add to the proposed work an introduction on elementary botany, but he thought a handbook of the flora of Tasmania would supply a much-felt want.

Mr **Rodway** said what he proposed to do was to refer the student to certain handbooks, and not exactly supply an introduction on elementary botany.

The Secretary pointed out that a work like Mr. Rodway's could not be published at the expense of the Royal Society, but the Royal Society might take it in hand, and approach the Government and get it published under similar conditions as Mr. R. M. Johnston's valuable work, entitled, "The Geology of Tasmania." No doubt the Government would recognise the importance of this work as they did with that of Mr. Johnston, and make provision for its publication.

The part of the work prepared by Mr. Rodway was remitted to the Council of the Society for their consideration.

TASMANIAN APPLES IN LONDON.

Mr. W. E. **Shoobridge** read a paper entitled "Tasmanian Apples in London." He said:—The export of Tasmanian apples to London opens up a wide and interesting field of inquiry to the student of physical science, as well as a source of profit to Tasmanian growers, and pleasure to consumers in England, and being intimately acquainted with the subject from the beginning, he had thought some account of its history would be interesting to this Society, and form a record of the initial steps taken to establish what now appears likely to be of colonial, if not national, importance. The soil and climate of Southern Tasmania have long been noted for their suitability for growing and maturing all the fruits of a temperate climate in perfection; and as the industry gradually extended from Hobart, southwards to the Huon, and north-westerly up the Derwent Valley, a distinct difference was discovered in the growth, and consequent treatment necessary in the two districts. In the Huon the heavy rainfall and damp climate, and fertility of virgin soil fresh won from the dense forests produced a luxuriant growth of large sized fruit, and orchards quickly spread along the narrow valleys and crept up the steep hillsides until it became the staple industry of a great part of the district, and the main dependence of a number of small settlers. The Derwent Valley extending inland, and gradually widening in a north-westerly direction out of the line of the great mountain ranges of the west that cause the moist climate of the Huon, is dry and arid, and the system of fruit growing, especially that of apples, that had been so successful in the Huon, failed when applied to the Upper Derwent. But small patches of the river flats near New Norfolk that received the drainage from the hills, and some that were irrigated for hops, were found to produce excellent fruit; through information about irrigation and its effect on growing and maturing fruit was difficult to obtain, and such knowledge as could be gained by fragmentary description of Indian and Italian irrigation, needed adapting to the special wants of our own soil and climate. Besides a strong though unreasoning prejudice existed against fruit grown by artificial watering, as it was said to be soft and green, though large, and destitute of flavour and keeping qualities, and at the same time irrigation appliances were costly and hard to get. But the indomitable energy of the Anglo-Saxon, when once fairly applied to the problem, slowly but surely overcame the difficulties, and brought success out of seeming failure. The first step was to get an accurate knowledge of the climate, and this was obtained by a careful series of observations, extending over many years, by which it was found that the average rainfall at New Norfolk for the year was 23·22in., and the spontaneous evaporation 45·36in.; and for the summer months of December, January, and February the mean average rainfall was 5in., and evaporation 15in., the mean temperature of three daily registers, 62·36deg., the mean of maximum solar intensity 134·88deg., of minimum terrestrial radiation 41·51deg., and humidity of air ·68 per cent.; of course this means an exceptionally dry summer climate for cultivation, and explained the reason of the failure of the Huon system when applied to the Derwent, but the mean amount of cloud of three daily registers (7·30 a.m., 4.30 p.m., and sunset) was only 4·20 of scale 0—10. He gave these and other figures in order that those who may wish to investigate the subject, either as a matter of inquiry, or for the purpose of establishing the industry in other places, may have some reliable data to go on. The next step was to find out the effect of water on the growth and maturing of the fruit, and after a patient and extensive series of trials, with nearly 100 varieties of apples, on different soils and situations, and varying amounts of water, applied at all stages of growth, as well as the effect of many systems of pruning, manuring and cultivation it was found that the water principally acted as a carrier or medium, by means of which the plant was fed, and the action of growth, consisting as it does of a constant absorptien of water by the roots, carried up to be exposed to the sun and air, and by the action of the chlorophyll cells, the hydrogen of the water combining with the carbon dioxide in the air, forms the series of hydrocarbons, that are the basis of all plant life, and by the addition of the salts and acids held in suspension by the water from the soil, and acted on by heat and light, causing the chemical changes and combinations that build up the different parts of the plant, and mature the seeds and their covering, that is, the fruit. It was found, that given a sufficiency of moisture in the soil to dissolve the chemical matters contained in it either naturally or artificially supplied when wanting, the essential point was to ensure a free circulation of air and access to light, of every part of the tree and fruit, and also to aerate the soil by constant moving, so that the roots could have air as well as water. The amount of water required to do this in the friable loam of most parts of the Derwent Valley, was found to be 30in. for the three summer months, and as the absence of cloud meant more sunshine, the dryness of the air was a positive advantage in maturing and colouring the fruit, as when a free growth was kept up by the constant artificial supply of water, the maturing was hastened, and as the fruit was more fully developed, the flavour and keeping qualities were vastly improved. The accuracy of these observations is confirmed by the researches of Dr. Julius Von Sachs on the transpiration of plants, which show that when it is increased by light and heat in a dry air, the passage of water from the soil is hastened, and by its evaporation in the stomata of the leaves, more of the salts in suspension are left in the chlorophyll cells, and consequently there is a rapid increase of the substance of the plant. The effect of this system, varied with the sort of apple and method of pruning, and finally the sturmer pippin, scarlet nonpareils and French crab were selected as the most suitable varieties, as well as being the healthiest trees and heaviest, and most regular croppers, and by their firmness of flesh and toughness of skin, best adapted for the rough usage of travelling. Of these the sturmer pippin is most improved by watering. It is satisfactory to find that these three sorts are pronounced by experts in the London fruit trade to be the best in flavour and appearance to please English customers. The style of preserving known as the inverted pyramid, formed by a number of branches radiating from the stem, a short distance from the ground, was found the best shape to allow free access of light and air to every part, as well as easiest to pick and prune, and least liable to damage from wind. Having selected the apples and learnt the best method of growing, the next difficulty was in transport. A six or seven weeks' journey, part of which was through a climate absolutely destructive to the apple, seemed at first an insuperable obstacle, but by the same method of patient observation and experiment, aided at last by the co-operation of growers, the dangers to avoid were gradually found out, and a knowledge was gained of the conditions necessary for the successful transport of fruit to London. First of all experiments were made ot the amount of heat apples could stand without injury, and it was found that 70deg. was about the limit of safety, but the heat of the tropics, both in water and air, averages about 90deg. for 10 to 14 days of the voyage, so artificial cooling was a necessity. The success of the dry air refrigerating process for carrying meat naturally led to inquiries to see how far it could be utilised for carrying fruit. A serious difficulty existed in the fact that the fruit season lasting so short a time meant that only a single trip of each steamer in the year was available for the trade, and the fruit being so susceptible to taking up foreign flavours, as well as liable to damage other things, no other article could be carried in the same hold, so freight could only be secured by guaranteeing to fill the whole of the cool chamber in each boat carrying fruit at the high rate of 90s. to 100s. per ton freight, growers taking all risks. The knowledge gained by so many years of patient inquiry and experiment had established the following facts :—1st. That at least three kinds of apples of excellent flavour, appearance and keeping qualities could be produced in greatest abundance and perfection, especially in the Derwent Valley district, and that the supply could soon exceed the demand of colonial markets. 2nd. That an almost unlimited market existed in England for this class of fruit, and owing to the difference in season, could be landed in London at a time of year when it would not have the competition of either home grown or American growth, and consequently good prices might be expected for the quality of fruit produced here. 3rd. That the fruit would keep in good order for at least double the time required for the voyage, provided the right condition of temperature and ventilation could be secured. 4th. That the yearly increasing number of ocean steamers fitted with cooling apparatus provided the means whereby a very large quantity of fruit could be carried. It now became necessary to secure the co-operation of growers, so that a sufficient number of cases could be collected to fill the cool chambers of some of the ocean steamers. By this time growers had so much confidence in the knowledge gained as to induce them to risk enough fruit to make the experiment. Accordingly in 1888 the first shipments on a large scale were made, although small experiments in shipping had been made for many years with varying success, and it was thought if they could only be kept cool enough through the tropics, there would be little danger in the venture. These first large shipments, however, only served to show the number and magnitude of the difficulties. In the first place the refrigerating machinery was designed for carrying meat, the essential condition of which was that it should be kept below freezing; but freezing was ruinous to apples, and some cargoes were nearly all spoilt by this cause and even when saved from frost the great amount of condensation of cold air from machine coming in contact with the damp air in the hold was very injurious, and in addition to this the want of proper ventilation in parts of the hold favoured a fungoid growth that spoilt the flavour even when it did not cause rot, and the rough handling of the fruit by stevedores unaccustomed to such easily bruised articles, was, and still is a serious loss, as the short time allowed for the loading makes careful handling very difficult. Improvements are gradually being made in tempering the air entering the cool chambers to prevent freezing and excessive condensation, and in thoroughly ventilating every part of the hold to prevent mould; and a new system has been proposed, adapted for ordinary holds, by fixing an exhaust fan to draw the air from every part of the hold by a reticulation of fixed pipes, and passing the inlet air through a chamber (supplied with cold air from the refrigerating machine) by a series of small pipes, so as to cool the air in passing through, and also to condense the moisture in the air before coming in contact with the fruit. It appears probable that the fungoid growth found in the holds on some of the fruit is anaerobic, and therefore fresh air should be constantly passed through all parts of the fruit to prevent its growth. It is found that the fruit when landed in London is very much riper than similar fruit kept till the same time in Tasmania; this cannot be caused by temperature alone, as the records of temperature of holds are almost identical with recorded observations in Tasmania for same time, viz., 35deg. to 65deg., and is probably due to a certain fermentation set up in the fruit by the natural process of decay, induced or at least accelerated by the fungoid growth found in the holds, and it is on these points that further information is required, viz., 1st. The amount of fresh air required daily by the fruit. 2nd. The range of temperature necessary for safe carriage. 3rd. The cause of fungoid growth in holds. 4th. The cause of premature ripening. 5th. The means by which these fungoid growths and fermentation may be prevented, and ripening of fruit in holds be retarded. It is known in a general way that fruit will not keep as well in a close room as when it is freely exposed to fresh air; that it will endure a range of from 35deg. to 70deg., if changes are not too sudden; that fungoid growths are promoted by a close, damp air; and that when kept in a close room at an even temperature of, say 45deg. to 55deg., it ripens and rots far quicker than in the open. As yet, however, we have not sufficiently accurate information on these points to say definitely how much fresh air and how low a temperature is necessary to carry fruit in the best possible condition, and it is a slow and costly process to acquire it, because, as stated before, only one trip in the year can be taken by each steamer and the experiments have to be made on such a large scale to be of any value; for instance, to test the cool ventilation in ordinary hold will require from 15,000 to 20,000 cases in a single vessel, and it is only by carefully noting the cause of failure that we can find out and apply a remedy. This was notably the case with ventilation. Experiments on a large scale were made in storing fruit in cellars and specially constructed stores, and it was found that the quantity stored in one bulk materially altered the results, and the conditions on the voyage were so different from those in Tasmania, that fresh precautions were needed on shipboard to those on shore. By the willing aid and co-operation of the chief engineers of the different steamers, much has been learnt. For instance by a careful register of thermometers in all parts of the holds it was found that through want of ventilation great differences existed, as much as 28deg. in a distance of 7ft. 6in. apart, and by carefully watching the condition of the fruit as it was unloaded from the different parts, it was found that at the inlet pipes of cold air to hold the fruit was mostly damp and sometimes frozen, and near the outlet pipes it was dry and in excellent condition, whilst in places round the bottoms a damp and mouldy appearance proved the stagnant state of the air. In this latter case the fruit had lost its fine flavour, and although clean and bright in appearance, was comparatively valueless. In spite of all failures and difficulties, it is satisfactory to note that a large amount of success has attended the venture; out of 130,000 cases sent in 1891 to London, at least 110,000 cases of excellent fruit were landed in good order, and was duly appreciated by English consumers of all classes, from Her Majesty the Queen—who was graciously pleased to accept a sample—to the humble customers of Whitecross-street costermongers. Although not of strictly scientific interest, it is yet important to notice the method of sale and distribution, about which much misconception appears to exist. It must be remembered that in this trade we cannot have everything our own way; as it is only comparatively small and intermittent, we cannot have ships specially fitted with machinery and appliances solely for fruit, but must make use of what is already provided with such alterations and modifications as our experience may suggest, and we can persuade steamship companies to adopt; so in the sale and distribution of fruit in England. We find an immense organisation reaching to every part of the country in active work, controlled by a few large firms of brokers in London. It would be quite impossible, for so short a time as we require it, and for a single article, to organise any system that could attempt to deal with the business as it can be done by the existing method; but, as in the case of transport, we may, by careful observation and experiment, see how far we can make use of this organisation to dispose of our fruit with the best results to ourselves. With this object we have established an agency in London, to reduce expenses, to control sales, to find out so as to prevent or make claims for all damages, and generally to exercise a supervision on behalf of growers.

Discussion on this paper was postponed till next meeting.

The Secretary read a paper contributed by Mr. J. Shirley, B.Sc., of Queensland, a corresponding member, on "A list of the known lichens of Tasmania," and one by Mr. A. T. Urquhart on "Some Tasmanian spiders," from a collection supplied by Mr. A. Morton, curator of the Tasmanian Museum. The other papers on the agenda were held over till next meeting.

The CHAIRMAN proposed a vote of thanks to the gentlemen who had contributed papers, which terminated the proceedings.

MAY, 1892.

The monthly meeting of the Royal Society of Tasmania was held at the Museum on Tuesday, May 11. His Excellency the Governor Sir R. G. C. Hamilton, K.C.B., LL.D., presided. There was a good attendance of Fellows.

His EXCELLENCY expressed his regret at being absent from the last meeting. This was the first time he had been with them since the late Science Congress had met, and he congratulated them upon the success which had attended their labours in this respect. This was, he was sure, largely due to the exertions of Mr. A. Morton, the General Secretary, who had been indefatigable in his efforts to make the affair a success. Mr. Ogilvy had thrown out a very valuable suggestion, to which reference was made in his address at the meeting of the Science Association. The idea was that they should have corresponding members stationed in various places. The country should be mapped out into districts, and each separate district be recognised as being under certain persons' observations, who would undertake to forward anything of any importance which might come under their notice in their particular districts. They might also be communicated with at will upon the subject, and inquiries instituted. He would like the matter to be discussed at the next meeting of the Society. Perhaps they might think the matter over, and make preparations for the discussion in the meantime. He then invited discussion upon the paper of Mr. W. E. Shoobridge.

Mr. A. MORTON said that the suggestion of Mr. Ogilvy was bearing fruit already. He had received a number of specimens from different parts of the island. One was a specimen of a very large crane (*Ardea pacifica*) seldom found in Tasmania, although common in Australia. Another was a white crane (*Herodias alba*) also scarce here. A duck, hitherto unrecorded in Tasmania, called the "blue bill" (*Erismatura australis*) was also sent. The Australian coot was another species of bird rather scarce in Tasmania, and recently found here in some plenitude. He was at a loss to account for the influx of these birds into the island at this period.

His EXCELLENCY stated that he had observed that the crane species were unusually plentiful this year.

THE EXPORT OF APPLES.

Mr. C. H. **Grant**, with reference to Mr. Shoobridge's paper upon the export of apples to Europe, said that the author of the paper had dealt with the question in a very able manner, although it was rather deficient in the details relating to the cultivation of fruit, which, however, might possibly relate more to the gardening industry than to the Royal Society. The paper itself could bear a great deal of argument. He was not in a position to criticise it, for it carried a great deal of information, and contained matter of interest. From a scientific point of view it was invaluable. In the earlier days of fruit-growing there was a great amount of labour wasted, and money expended in cultivating the wrong kind of fruit. It was always a matter of interest to study the products of the soil, and he was sure the Society was much indebted to him. Mr. Shoobridge had also given some valuable information concerning his meteorological surveys, in which he was a pioneer. They were all, he was sure, greatly pleased with the efforts of Mr. Shoobridge in the researches he had made, and for the valuable information he had furnished.

Mr. W. E. **Shoobridge** said that there were two points which were very necessary to discuss on the subject; one was the question of irrigation, and the other the effects of the atmosphere upon the growth of fruit. The finest fruit he had ever seen was grown in a dry atmosphere, where the trees had been well irrigated. The reason for this was that the trees required as much light and air as possible. The water acted as a carrier of soluble salts, necessary to the life of the trees. The more sunlight and air that was received by the trees the greater and more active were the chemical changes, and the higher products of the plant. The gums, resins, and sugars were more abundant. It was impossible to get this in a moist atmosphere. The French crabs usually grown in a moist atmosphere were, when grown in a dry, airy locality, completely changed in colour. This was very apparent in trees which were grown within a short distance of each other. They also had adopted a new system of pruning. In this climate the full benefit of the sun without too much strength was received, which was of the greatest value. The damage to the fruit in keeping was the result of a fungoid growth produced by the fruit being stored in places where the air was foul. To keep this under it was necessary that the fruit should have a clear current of air. In an atmosphere of 40deg. to 50deg., which was about the proper temperature to keep fruit in, with a clean dry atmosphere, the fruit would keep well. In some of the fruit which had been packed to London a blue mould appeared about the specimens, and on tasting it its flavour was found to be entirely gone. This fungi, which began usually about the region of a bruise, caused immense harm to the fruit, and completely spoiled its flavour. This was never found in the packed fruit near the outlet, because there was a complete current of air. In the places where the fruit was affected the air was very foul, so foul in fact, that in some cases a candle would not burn. It was therefore apparent that the fungi was nourished in stagnant air, and, if information could be gained with regard to this matter, a great step towards the knowledge of the proper course to be dopted for the preservation of fruit would be gained.

His **Excellency** thought that if information was sent in from various districts respecting the question of irrigation, and how it was applied, it would be of great value. He asked if there were many districts where irrigation was carried on?

Mr. **Shoobridge** replied that there were not very many, although the question was receiving more attention lately than formerly. There were a great many districts where irrigation was not required.

His **Excellency** thought that it was a pity if the subject should stop at that place. If Mr. Shoobridge would confer with Mr. Morton a series of papers on the subject might be prepared, and if communication were established with different fruit growing districts information might be obtained of much value.

The meeting adopted the suggestion as a favourable one.

Mr. **Grant** said that in his researches he had noticed that in places where fruit had grown to extraordinary proportions, like the district of Nova Scotia where the climate was not of the particular conditions described by Mr. Shoobridge as most favourable, the great depth of soil was perhaps the real cause. He noticed that in the valleys of Nova Scotia the English grasses and clover grew to such a height as to resemble a dense scrub. He did not think that the winter of Tasmania was severe enough to kill the insect pests.

His **Excellency** thought that Messrs. Shoobridge, Grant, Abbott, and Morton, if willing to act, might constitute themselves a body to obtain all information possible upon the subject with a view of reducing it to a practical form.

PAPERS.

"The Climate of Eastern Tasmania, indicated by its Lichen Flora:" by Rev. F. R. M. Wilson, Kew, Victoria, Corresponding Member Royal Society, Tasmania:—

During a visit of five weeks to Tasmania, in February and March, 1891, while exploring for lichens in the neighbourhoods of Launceston, Mount Arthur, Ulverstone, Hobart, Mount Wellington, the Huon River, and St. Mary's Pass, I was struck with the general and unexpected poverty of the lichen flora. And, on looking about for the cause of this, I noted the evident frequency of bush fires, which are the most destructive enemies of lichen growth. This, however, did not wholly explain the matter, for, even where the plants might be expected to recover from the action of the fire, their vitality seemed to be checked by the dryness of the climate. This was a discovery surprising to a Victorian, who had been accustomed to consider the climate of Tasmania a humid one. An examination of meteorological authorities, however, showed that in the eastern portion of the island the rainfall is not only less than it is in the western, but less than it is in Victoria. In the west and the highlands of Tasmania 75in. of rain have been registered in one year, and the average of the whole island is said to be 35in.; but the annual rainfall at Hobart is only 21·52in. These adverse influences of fire and drought doubtless re-act on one another; the fires thinning the forests and undergrowth and thus lessening the rainfall, and the lack of rain exposing the country to the ravages of fire. These influences, however, are considerably modified in the eastern part of Tasmania by the altitude of the mountains and by the ocean currents along the coast; both of which have a great effect upon the geographical distribution of lichens. When I visited Tasmania I was anxious to test a theory which I entertained with regard to the distribution of lichens in Australia. This theory was that the warm current from the tropical Pacific Ocean, passing down the east coast of Australia, carries southward the spores of tropical lichens and the conditions favourable to their growth, until it is met by the cold south-west seas and winds which greet the traveller when doubling Wilson's Promontory from the east. Nautical observations have determined the trend of this coastal current, and traced it from the tropics southward beyond Australia and along the eastern coast of Tasmania. Nylander tells us (Syn. Meth., p. 69) that the tropical zone is specially characterised by its epiphyllous lichens, notably by the genus *Strigula*, and, among cortical lichens, by the numerous species of *Thelotrema*, *Graphis*, *Chiodecton*, *Glyphis*, *Trypethelium*, and *Porina*. These genera, which are allied to the *Ascomycetes* among the fungi, are largely represented in Queensland, on the eastern or seaward side of the coastal ranges. All of these, except the *Porinæ*, appear along the coast of New South Wales, but are less numerous there both specifically and individually. In Victoria neither *Strigulæ* nor *Porinæ* have been found, unless in a very undeveloped state, and the other genera have far fewer representatives than in the more northern colonies. They are most frequent in the eastern part of Victoria. I discovered many species of *Graphis* and *Thelotrema*, and several *Chiodecta*, on the seaward slope of the dividing range to the east of Melbourne, and especially on the Gippsland coast, and one *Glyphis* and one *Trypethelium* at the lakes entrance in Gippsland. It remained to be seen whether or not my theory would be supported by lichenological explorations in eastern and north-eastern Tasmania. I had opportunity to test it on Mount Arthur and in St. Mary's Pass; and I found some of the same *Graphides* and *Chiodecta* and even a *Trypethelium*, which I had collected near Sydney and at the lake entrance in Victoria. Two or three species of *Chiodecta* I found, not only on Mount Arthur, but even as far south as Mount Wellington. The genus *Trypethelium* is especially tropical or sub-tropical, and the presence of one of this genus in St. Mary's Pass testifies to the geniality of the climate in eastern Tasmania. As in Victoria, so in the more southern colony, the warm current down the east coast of Australia brings southward conditions favourable to the growth of sub-tropical lichens. These facts, I think, suggest to the medical faculty what probably their experince has already proved, that the climate of east Gippsland and the eastern coast of Tasmania must be pre-eminently beneficial to invalids. Lichenological observations indicate that both of these places are favoured by a much milder winter, as well as a cooler summer, than the other parts of their respective colonies.

Mr. Grant thought that the subject was a most interesting one from a botanist's point of view, and from the specimens laid upon the table it would seem that they were beautiful in form, and extremely interesting in every way. The collection of mosses were well worth looking at. They were done up in a most convenient form for examinations. There was no difficulty in getting at them, and the names were put upon them clearly and legibly. The Society was, he was sure, deeply indebted to the donors, from whom he hoped to have more shortly.

CORRESPONDENCE.

Cullenswood House, St. Mary's, May 2, 1892.—The Secretary of the Royal Society of Tasmania. Sir,—Having received a communication from Mr. E. D. Atkinson, of Wynyard, relative to the terrible destruction of the young of Puffinus brevicanda, or "mutton bird," at the Straits Islands, for the boiling down of their fat, I beg to bring the matter strongly before the Council of the Royal Society, with a request that a deputation of its members may wait upon the Government, and suggest the passing of an Act during the coming session of Parliament, which shall put a stop to the destruction of this species for the purpose complained of. I cannot do better than transcribe from Mr. Atkinson's letter what he says in reference to the slaughter of the birds :—"When I was there, and for some time previous, the young birds were being taken for the purpose of 'fatting,' that is, boiled down for their fat. On Green Island alone, five men were obtaining 2,500 birds a day, and this would be going on for several weeks. On Chapel and Babel Islands, which are much larger, the same thing was going on, but on a much larger scale. Some hundreds of thousands will be destroyed in this manner, and when I tell you the fat is 9d. per gallon, and it takes 120 birds to make one, you will see what rightful destruction is done for a miserable return. It is perfectly legitimate to take the birds for curing and keeping for food, but as there are too many for this they must destroy them in a wholesale way for fat; and this is done by one or two men only, the majority of the folks there and all the half-castes are against the fatting process. I was requested when there to see if anything could be done to have a stop put to it." This extract speaks for itself, and the points to be urged on the Government are:—The enormous destruction for a disproportionate, and as Mr. Atkinson says, a very miserable return, and the undoubted fact that the mutton birds will in a few years be driven way from these breeding haunts altogether, and the means of getting a living resorted to by the islanders entirely cut from under their feet.—I have the honour to be, sir, your obedient servant, W. V. LEGGE, Tasmania, Member of Committee for Preservation of Plants and Animals.

Mr. BERNARD SHAW said that perhaps Colonel Legge probably was not aware that there was a law to prevent the destruction of young mutton birds. This prohibited the taking of birds until they were fit for human food, and was instituted especially to prevent their wholesale destruction. This was the first season that the regulation had been in force, and he hoped that it would have a salutary effect. The constable who had charge of the islands was only recently appointed, and it would be his duty to see that the Act was carried out.

Mr. THOMAS STEPHENS hoped that the Act would be carried out efficiently. It was a subject which could scarcely be discussed without preparation. The birds formed the staple food of a half-caste population of the Straits, and they should be either compelled to restrain themselves in the wanton destruction of the mutton birds, or else be removed to another place. The natives could not be made farmers all at once, but their condition was being greatly improved. He regretted the absence of Bishop Montgomery, who had made himself acquainted with the condition of the half-castes in the Straits thoroughly. At certain seasons of the year the natives of the islands assembled to snare the birds. This had been going on for at least 50 years, and there did not appear to be any appreciable diminution in their numbers. He thought that if the law was a good one it might be very strictly enforced, as there were too many laws on the Statute Book of Tasmania already which were allowed to rest dormant.

Mr. SHAW said that there were four matters to be dealt with. The first was the destruction of the young birds, the next the taking of the eggs, the next the destruction of the birds by fire, and lastly, the injury done to the birds by the presence of cattle and sheep. He read the regulations in force upon the subject, which provided against the destruction of the birds as stated in the paper of Colonel Legge. These regulations were issued on the 12th December last.

PRESENTATIONS.

The Secretary called attention to a number of donations which had been sent to the Museum. Mr. W. A. Weymouth forwarded 85 specimens of mosses comprising 68 species. The Rev. F. R. M. Wilson sent in a number of specimens of lichens, which were like the mosses, mounted and classified. Mr. Omant presented samples of rocks from the West Coast, consisting of calcite and limestone, and which were said to be valuable for flux, analysis of which has already been published. A specimen of stone found near the Russell Falls was submitted by the Secretary to Mr. A. Montgomery, the Government Geologist, who said that on examination of it he found that it was not kaolin but pretty nearly pure silica, probably tripoli or infusorial earth. He stated that the infusorial earth had a considerable commercial value if of good quality, and he quoted the U.S. mineral statistics, it was shown that the production of 2,532 tons of 2,000lb., valued at 50,640dol., or about £4 a ton. This stone was found in connection with the lithographic stone recently referred to in a previous issue of *The Mercury*.

PAPER BY PROFESSOR TATE.

A paper was handed in by the Secretary, contributed by Professor Ralph Tate, F.L.S., of Adelaide, on the "Classificatory portion and synonyms of *Eaetoniella Rufilabris*."

After the usual votes of thanks the meeting terminated.

JUNE.

The monthly meeting of the Royal Society of Tasmania was held in the Society's room at the Museum on Tuesday evening, June 14. His Excellency the Governor Sir R. G. C. Hamilton, K.C.B., LL.D., presided, and there was a good attendance of ladies and gentlemen.

A NEW MEMBER.

Mr. Charles Holdsworth was duly elected a Fellow of the Society.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE JOURNAL.

The SECRETARY (Mr. Alex. Morton) laid on the table Volume III. of the journal of the New Zealand meeting, which had just arrived. He also said the journal of the Hobart meeting was well in hand.

His EXCELLENCY expressed himself as highly pleased that the publication of the Hobart journal was being done so expeditiously.

CORRESPONDING MEMBERS.

The SECRETARY stated that the Council had under consideration Mr. Ogilvy's suggestions with regard to corresponding members throughout the country, and hoped to be able to report on it by next meeting.

PAPERS.

Notes on the Natural Limits to Occupation on the Land, by Mr. R. M. JOHNSTON, F.L.S.

Notes on the Square-set System of Timbering in Mining at Zeehan and Dundas, illustrated by a Model Square-set. By ALFRED J. TAYLOR, F.L.S.

His EXCELLENCY moved a vote of thanks to the gentlemen who had contributed. As regarded Mr. Taylor's paper, he was sure they had all listened to it with great interest. The explanation he had given was very clear, and he had no doubt his object would be fulfilled if the general attention of the mining public was directed both to the advantages and drawbacks of this description of timbering. (Applause.)

The proceedings then terminated.

JULY.

The usual monthly meeting of the Royal Society was held at the Museum on Tuesday evening, July 12. His Excellency the Governor

Sir Robert G. C. Hamilton, K.C.B., LL.D., presided, and there was a large attendance.

The Secretary stated he had received a telegram from Mr. Russell, the Government Astronomer of New South Wales, informing him that it would be impossible for his paper to arrive in Hobart by that night's train. The paper was one of very great importance, dealing as it did with the late Leake bequest in connection with astronomy. Under the circumstances he would ask for the paper to be postponed till next meeting.

SOME PLANTS NEW TO TASMANIA.

Mr. LEONARD RODWAY read some notes on this subject.

Mr. A. J. OGILVY read a paper entitled "Artificial obstructions to the occupation of the land."

The Rev. Dr. SCOTT, and Messrs. C. H. GRANT and A. J. TAYLOR spoke on the subject.

The Secretary (Mr. A. MORTON), on behalf of Colonel W. V. Legge, R.A., read a paper "On the Occurrence of some Australian *Ardeidæ* in Tasmania," discussion being postponed.

The meeting closed with a vote of thanks to all who had taken part in the proceedings.

AUGUST, 1892.

The monthly evening meeting of the Royal Society of Tasmania was held at the Museum on Monday, August 8. The President (His Excellency Sir Robert G. C. Hamilton) K.C.B., LL.D., presided, and there was a good attendance of Fellows.

CORRESPONDENCE.

The SECRETARY (Mr. Morton) read a letter from Mr. H. C. Russell, the Government Astronomer of New South Wales, with reference to his paper on the Leake bequest. The writer said he had ascertained that it would not be possible to get for Tasmania one of the telescopic instruments sent to South America. It would, therefore, be necessary to order one from the manufactory—either Sir Howard Grubb or M. Gautier, of Paris. Sir Howard Grubb's price was £1,800. He was unable to ascertain M. Gautier's figures. About 12 months would elapse from the date of the order until the instrument was ready for use. He had made no provision in the paper for architect's fee, as he had drawings and specifications for the Observatory which would serve the builder's purpose. For teaching purposes it would be convenient to have the Observatory close to the University, but as far from the railway as possible, as the vibrations caused by trains passing would to some extent interfere with photographic work. He hoped the Leake trustees and the Council would be able to carry out the proposal. The time for the institution of an Observatory in the southern hemisphere was most opportune and might not come again for years.

THE LEAKE ASTRONOMICAL BEQUEST.

Mr. A. MORTON (Secretary), in the absence of the author, read a paper entitled the proposed "Leake School of Practical Astronomy," by Mr. H. C. Russell, F.R.S., the Government Astronomer of New South Wales :—

Mr. RUSSELL said during his visit to Hobart in January last he was struck with the brightness and translucency of the atmosphere, and it was evident to him that the weather of the fortnight he was in Hobart would have enabled him to do as much as he had done in Sydney during the preceding two months. And, in conversation with some friends, he expressed regret that such fine skies for the astronomer should not be taken advantage of, and an Astronomical Photographic Observatory established. He was told that Tasmania, like other parts of the world, was passing through a period of commercial depression, and the Government did not seem to be disposed to add to expenditure by starting an Observatory, but that the late Mr. Leake had left a sum of £10,000 for the foundation of a School of Astronomy, and it was hoped that an Observatory would be established very soon. And it seemed to him most fitting that the colony in which this noble bequest was made should be the first to take it up and benefit by its provisions; and the establishment of a Tasmanian University would, with the co-operation of the Council, enable the trustees to carry out in a most satisfactory manner the wishes of the testator, who indeed seemed to have contemplated such a natural combination as that now proposed between his trustees and the Council of the University for the establishment of a School of Astronomy. Such an addition as this to the functions of the University would be an immense advantage. In the first place, it would add to the curriculum another subject which students may take up, either as technical education or as a most valuable mental training in a general course of study. Next, it would induce some students to come to the University in order to attend the lectures on Astronomy, and if provision were made for non-matriculated students to attend the teaching in practical astronomy on payment of fees, there could be no doubt that many would enrol their names. The desire to contribute in some way towards the consummation of the proposed Observatory scheme, which seemed to him so desirable, and so easy of attainment with the means at command, had induced him to make the following suggestions; but before going on to these Mr. Russell said he would wish to point out that Hobart, in addition to its clear atmosphere, possessed in its high southern latitude a great advantage over any other available place for the new Observatory in the southern hemisphere. It was true that a slightly higher latitude was available in New Zealand, but the climate was less favourable, and the means to build an Observatory were apparently not forthcoming, and if one were erected in New Zealand it would no doubt be at Wellington. So that, practically, Hobart not only possessed the means, but also the best available site in the southern hemisphere for the Leake Observatory.

The paper dealt very fully with the subject, giving an estimate as to cost, etc.

The REV. GEORGE CLARKE, Vice-Chancellor of the University, said: I am sure that I only express the universal sentiment when I say that our very warmest thanks are due to Mr. Russell for the able and practical paper which has been read to this meeting. It is full not only of his interest in the general cause of science, but of his interest in the particular honour and welfare of Tasmania. One does not need to be an expert to accept his assurance that for position, climate, and atmospheric conditions the neighbourhood of Hobart is probably the best place in the Southern Hemisphere for astronomical observation. There are problems waiting to be solved for which we can furnish the *data* more easily than they can be obtained elsewhere; and of Mr. Russell's kindly feeling towards us, and his desire that we should have the benefit of our position, his paper is sufficient indication. As far as I can gather, it is the feeling of all the colonies that we should have the first and fullest chance of appropriating Mr. Leake's munificent bequest, and that it should only be on our failure in power to take it up that its benefits should be thrown open to the competition of the outside world. It would be satisfactory to know how far our opportunity of acceptance may be extended. We have not, of course, the slightest right to dictate to the executors of Mr. Leake's will, but we might suggest that the matter should not be finally disposed of until ample time is granted to us to avail ourselves of the bequest. As far as regards the proposed association of this fund with the University, I can only speak for myself, and may not commit the Council to any opinion that I may now express. We must all be struck with the very direct and practical character of Mr. Russell's suggestions. He contemplates chiefly the establishment of an Observatory, and the means of carrying on its work. No doubt in a new community like ours the immediate practical work is a great consideration. But as far as I can judge, the University Professorships in Astronomy in the Old Country look to the teaching of higher mathematics very much more than to the manipulation of instruments for the necessary qualification of professorship. I think we should have to invert the order of requirement and to look more to practice than theory, which would involve our taking a course for ourselves for which we need time and consideration. I received to-day a note from Mr. Waterhouse of Launceston, which indicates some of the questions we should have to thrash out. It is not an official note, and I will trust to my friend's forgiveness if, with your permission, I read it.

"LAUNCESTON, August 4th, 1892.

"MY DEAR MR. CLARKE,—I am afraid that Mr. Walker has considerably over-estimated my powers of making any helpful suggestions as to Mr. Russell's paper on the Leake trust, and the relation of the University to it. I have ransacked my ideas very fully, but cannot get anything very satisfactory out of them. I must take Mr. Russell's figures as correct, viz., £3,000 for apparatus, etc., and £7,000 for investment, producing £350. If the Lecturer in Mathematics and Physics is to give instruction in popular Astronomy, and is to supervise and control the University, it would not be fair to ask him to do this extra work,—work which is quit eoutside the duties set forth by the University in inviting applications,—without receiving extra remuneration, and this extra remuneration should come out of the Leake trust. The £100 a year proposed by Mr. Russell seems to be a fair estimate. The late Professor Adams (Professor of Astronomy and Geometry) at Cambridge, was entrusted with the superintendence and management of the Cambridge Observatory at an extra stipend. I knew very intimately the Observer at the Observatory, and I know this, that he did the usual every day work connected with the Observatory, reporting to the Professor from time to time. If the proposed lecturer has graduated as a wrangler at Cambridge, or has taken a degree in honours at any University where the course requires a knowledge of astronomy at all equal to what is required in the Cambridge course, there can be, I think, no doubt of his ability to do all the duties required of him under the Leake trust, especially if he rubbed up his knowledge of the instruments by attending for a few months at the Melbourne or Sydney Observatory prior to taking up his duties here. But what we shall require in order, in my opinion, to qualify the University to take the benefits under the Leake trust, is an Observer or assistant. There will be, after providing for the £100 a year additional salary to the lecturer, and the £50 required for annual incidental expenditure (according to Mr. Russell), only £200 for the observer's salary. That might enable us to get a capable man, without addition, although I rather doubt it. An extra £50 or £100 from the University funds might do so. Such an observer would, of course, be able to demonstrate at the lecturer's astronomical lectures, and might be able to demonstrate in Physics and do the photography. But I do not think that £250 or £300 a year would get us a man with both these capabilities. Still, with a lecturer and an observer to demonstrate at the astronomical lectures, we should, I think, qualify for the Leake trust, though, of course, not so fully as under Mr. Russell's scheme. If to the £200 left from the Leake trust the Government would add the £150 or £200 per annum recently voted to the meteorologist on condition of the observer's taking up those duties, which, of course, would fall in most easily with his ordinary duties, we ought to be able to get a very good man, and able to demonstrate in physics, and with some skill in photography. I wish to say again, and more emphatically than I have before, that I do not think we need import an astronomical expert in order to give the instruction in astronomy and to superintend the Observatory. When the late Professor Adams made his calculations which led to the discovery of the planet Neptune, he was engaged at tutorial work in mathematics generally, and had only taken his degree two years before; he made his calculations, apart from observations, and then communicated the result of them to Professor Challis and the Astronomer Royal, who, by observations, verified his calculations. And again, his *locum tenens* during his illness; and I believe now his successor, Mr. Hobson, of Christ's College, took that position, not by virtue of any special practical experience at the Observatory, but by virtue of his general excellence in mathematics, and I know that when he took his degree his astronomy was not his peculiar forte. I am afraid that we cannot, as I hoped we should have been able, provide for a lecturer in mathematics and a lecturer in physics out of the Leake trust and probable Government aid, *i.e.*, meteorologist's salary, for we shall have to provide for an observer and for incidental expenses.—Believe me to be, yours very sincerely, G. W. WATERHOUSE."

I think that in the circumstances such a resolution as I will now propose will best meet the case :—

"That the Secretary be requested to communicate with the Council of the University, and to ask if they are willing to appoint a committee to confer with a similar committee of the Royal Society on the Leake bequest to promote the study of astronomy, the joint committees to suggest and report to the Society and the Council such a scheme as may be practicable in order to secure the benefit of Mr. Leake's bequest to the colony of Tasmania."

His Honor, SIR LAMBERT DOBSON, Chancellor of the University, on seconding the resolution, eulogised the munificent nature of the bequest. To carry out their wishes it was necessary they should have the co-operation of three bodies, namely, the Leake trustees, the Government, and the Council of the University. If it was in no sense contrary to Mr. Leake's directions, he did not think that there would be great objection to the Observatory being established in this part of the Southern Hemisphere. So far as the Government was concerned, there was a sum on the estimates for the meteorological establishment, which he thought the Government would be glad to hand over towards the carrying out of such a scheme if the Observatory did the work. He was glad to notice the attention being given to that important branch of the subject—astronomical photography—and its great value in the science had already been abundantly demonstrated by experiment. It was for them now to work out all the details, and approach the trustees with a scheme which fully complied with all the conditions of Mr. Leake's bequest.

Mr. T. STEPHENS, Director of Education, anticipated that two or three years might elapse before funds were at the disposal of the trustees to give effect to the bequest. This was a serious obstacle to any immediate attempt to combine the functions of University Lecturer in Mathematics with the duties to be performed under the Leake bequest. The University must act at once in the matter of its own appointment. He moved—"That it is highly desirable that a school of practical astronomy should be established at Hobart in accordance with the suggestions of Mr. H. C. Russell, subject to such modifications as circumstances may require."

Mr. J. B. WALKER said that the paper which had been read was most valuable, not only as the testimony of a high authority to the pre-eminent advantages of Hobart as a site for astronomical work, and especially for stellar photography, but also for the clear and practical directions it contained as to the requirements of an Observatory and the cost of apparatus and maintenance. He thought that Mr. Russell's proposal would offer a strong inducement to the Leake trustees to bestow this noble gift within their own colony. Co-operation with the great Observatories of the world in the special work proposed would at once give the Leake Observatory a certain prestige, and the name of its founder would be associated with a scientific undertaking of universal interest and importance. This would be attained without detriment to the express object of the donor, which was the practical teaching of astronomy in connection with a University. It was premature to discuss details; but he might suggest that as it was impossible to divorce astronomy from the study of the higher mathematics, the Leake professor would naturally take the higher mathematical work of the University. With the co-operation of the different bodies mentioned by Mr. Clarke, arrangements might be made for two University lecturers. The lecturer in physics could take a part of the mathematical course, leaving the Leake professor free to give his whole attention to the astronomical work and the higher branches of mathematical study.

Extract from the will of Mr. Arthur Leake, late of Ashby, Ross, Tasmania :—

"I direct my said trustees to stand possessed of a third sum of £10,000, upon trust for the purpose of founding or establishing a school for the practical teaching of astronomy, in any of the Universities, colleges, or leading schools mentioned in Clause 6 of this, my will; [*i.e.*, in either of the Australian cities of Hobart, Sydney, Melbourne, Adelaide, or Brisbane;] a part of such teaching to consist of demonstrative lectures with diagrams and instruments. And I declare that it shall be lawful for the persons for the time being holding the said sum of £10,000 to lay out and employ £3,000, part thereof, in purchasing and providing instruments in aid of such teaching."

Another clause of the will authorises the trustees to pay over the said sum of £10,000 to the University in connection with which the school may be founded.

The REV. DR. SCOTT thought there would be insuperable obstacles the way of attaching the Leake bequest to the chair of mathematics. in The Leake bequest at the very outset contemplated the establishment of a school for the teaching of astronomy, and the whole terms of the will implied that the teacher should be a teacher of astronomy, having also attached his chair to the work of demonstration in such a way as to give up his time very largely to this important branch of learning.

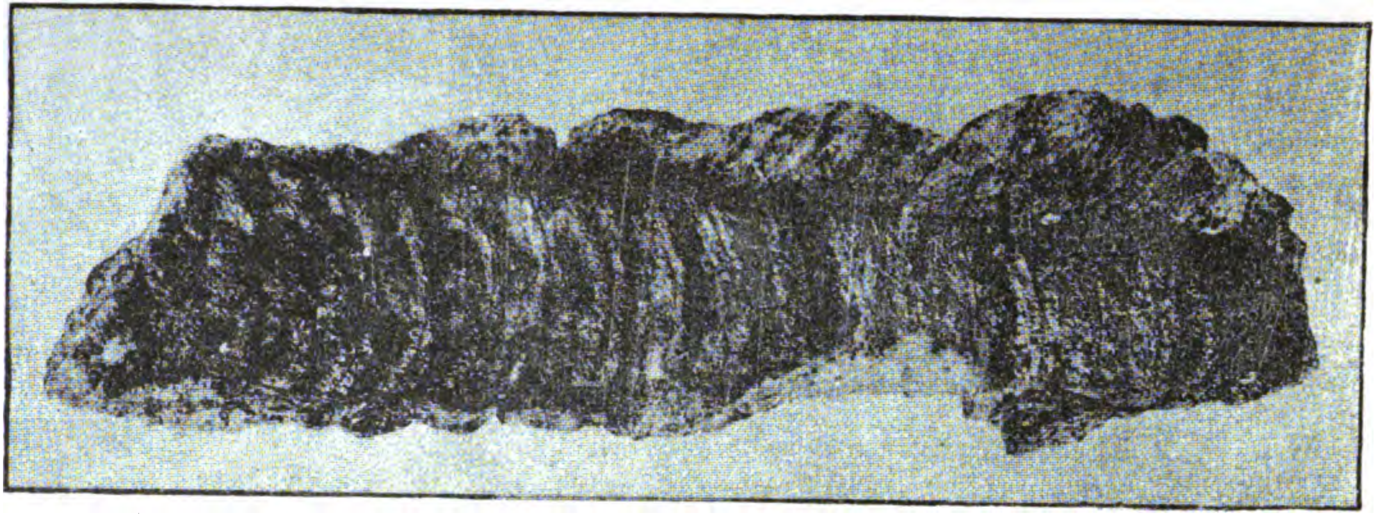
MR. H. C. KINGSMILL, M.A., dealt with the teaching aspect of the question, and thought that whilst the scheme contained many excellent points the duties in connection with the Observatory could not very well be undertaken by the professor of mathematics.

A further resolution was passed, on the motion of Sir LAMBERT DOBSON, seconded by the Hon. N. J. BROWN,—"The Royal Society having placed itself in communication with the Council of the University with the view of formulating a scheme for securing the benefit of the Leake bequest to the colony of Tasmania, the Premier be requested to refrain from making any permanent appointment to the office of meteorologist pending the result of such conference."

REMARKS ON SIR ROBERT BALL'S PAPER (READ AT THE HOBART MEETING OF THE AUSTRALASIAN SCIENCE ASSOCIATION), ENTITLED: "THE ASTRONOMICAL EXPLANATION OF A GLACIAL PERIOD."

BY A. B. BIGGS.

The author said he wished to refer to Sir Robert Ball's paper (read at the Hobart meeting of the Australasian Science Association),



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entitled "The Astronomical Explanation of a Glacial Period." He said that the purport of Sir Robert Ball's paper, which disputed some of the deductions of Sir Robert Herschel in his "Outlines of Astronomy," shows that the successive periods of glaciation, alternating with periods of genial or tropical temperature, which geologists infer from the indications of the rocks and strata, are necessary corollary from astronomical data. Having fairly stated the conditions of the problem, Mr. Biggs proceeded to say that the statement on which Sir Robert Ball founded his charge against Herschel could only be that on page 333 of the fifth edition of Herschel's "Outlines of Astronomy"—"Supposing the eccentricity of the earth's orbit were very much greater than it actually is, the position of its perihelion remaining the same, it is evident that the character of the seasons in the two hemispheres would be strongly contrasted. In the northern we should have a short but very mild winter, with a long but very cool summer,—that is, an approach to perpetual spring; while the southern hemisphere would be inconvenienced and might be rendered uninhabitable by the fierce extremes caused by concentrating half *the* annual supply of heat into a summer of very short duration, and spreading the other half over a long and dreary winter, sharpened into an intolerable intensity of frost when at its climax by the much greater remoteness of the sun." Reading this, however, with another extract from the same author, he thought Herschell's meaning would be sufficiently apparent, although he had in this case failed to express himself with his customary preciseness. His statement, said Mr. Biggs, is that "the hemisphere would be inconvenienced . . by concentrating half *the*" (not *its*) "annual supply of heat into a summer of short duration," etc., which is, of course, apportioned between the summer of one hemisphere and winter of the other alternately, and he can only be referring to that portion of this "supply" which pertains to the summer or winter of either hemisphere. That he could have meant nothing else is still more evident from a further quotation (page 230), in which he admits the unequal distribution of heat between summer and winter:—"Whenever, then, the sun remains more than 12 hours above the horizon of any place, and less beneath, the general temperature of that place will be above the average; when the reverse, below;" that is, the summer and winter portions of the year respectively. The extent of the inequality of the distribution of the annual supply of heat between the summer and winter portions of the year in either hemisphere depends wholly and solely upon the inclination of the earth's axis, and no one could be more cognisant of this fact than Sir John Herschel.

Mr. STEPHENS exhibited a specimen of an *Orthoceratite*, belonging to the genus *Actinoceras*, from the Silurian limestone at Railton, in the Mersey district, and stated that he had sent a portion of the fossil, which, when found by Mr. Hainsworth, was in three pieces, to Sydney for identification; but Mr. Etheridge said that it was not perfect enough to determine the species. The rock in which it was found was the same as that in which extensive borings had been undertaken on the pretence of searching for coal, and that too where the Silurian rock cropped out on the surface, and no coal measures existed.

TASMANIAN MOSSES.

The SECRETARY drew attention to a fine collection of Tasmanian mosses, beautifully mounted, and presented to the Museum by Mr. W. A. Weymouth, consisting of 57 specimens representing 50 species, making a total of those previously presented in May last by Mr. Weymouth, of 117 species.

The meeting terminated with the usual votes of thanks.

SEPTEMBER, 1892.

The monthly evening meeting of the Royal Society of Tasmania was held on Tuesday, September 13th. The President, His Excellency Sir R. G. C. Hamilton, K.C.B., LL.D., presided.

PAPERS.

Mr. R. M. JOHNSTON, F.L.S., in commencing the reading of a paper entitled, "What are the conditions which determine the just and equitable representation of the people?" said that instead of his paper being based on theory, having had much to do with the question of the representation of the people, he felt that he could give some information and advice. Also, he thought, the difficulties which presented themselves to his mind from time to time might be of service to those who had to deal with the question. To secure a just and equitable representation of the people in Parliament was a matter which had at all times engaged the attention of thoughtful, practical legislators, and great thinkers. The paper was listened to very attentively, and at the conclusion the Hons. J. W. Agnew, N. J. Brown, A. J. Ogilvy, and A. J. Taylor replied.

The Secretary (Mr. A. MORTON), read some notes on the habits of some Tasmanian insects.

His EXCELLENCY in proposing a vote of thanks to Mr. Johnston and Mr. Morton for their papers, said as regarded the former the subject was one of extreme importance and very great interest. It was very desirable that occasions should arise like the present when a question of that sort could be discussed in the calm atmosphere of a room like that, instead of creating as it might keen political feeling. (Hear, hear.) He had never before seen the question analysed, and as Mr. Johnston had treated it.

The meeting then closed.

NOVEMBER, 1892.

More than ordinary interest centred in the closing meeting for the present session of the Royal Society held on Monday. It was the last occasion on which Sir Robert Hamilton would preside at the Society's meetings, and also the time selected for the delivery of his valedictory address as President. The Art Gallery at the Museum was prepared, and provided splendid accommodation for the 200 or more ladies and gentlemen, members, and their friends, present on the invitation of the Council. His Excellency and Lady Hamilton were received by the Council and Secretary. The audience included the Premier (Hon. Henry Dobson) and other members of the Ministry. Apologies for absence were received from two members of the Council.

Mr. MONTAGUE RHYS-JONES, C.E., read an elaborate paper on the "Elgin Marbles, The Acropolis, Phideas and his Works, Historical and Architectural Description of the Parthenon, including the Pediment, Metopes, and Friezes." The paper was strictly classical, but the writer's lucidity, coupled with a number of lantern slides of the principal subjects skilfully thrown on the screen by Mr. N. Oldham, rendered the whole easily intelligible, and it was consequently much appreciated.

The following papers were taken as read:—"Note on the Voracity of the Kelp Fish," and "Note on the Tasmanian Acanthiza," by Col. W. V. Legge, R.A., F.Z.S. "Concerning various means of encouraging the Study of Natural History in Tasmania," by Mr. J. R. McClymont, M.A. "Notes on Tasmanian Crustacea, with description of New Species," by Mr. Geo. M. Thomson, F.L.S., New Zealand. "Notes on Some Plants New to Tasmania," by Mr. Leonard Rodway.

On the proposition of the PRESIDENT a unanimous vote of thanks was accorded the writers of the papers.

THE PRESENTATIONS.

The Hon. J. W. AGNEW (honorary secretary and senior vice-president of the Society), in prefacing the reading of the following address to the President, referred eulogistically to the warm practical interest Sir Robert Hamilton had displayed in the operations of the Society. In comparing his Excellency's active work for the Society with the indifference of other influential members of the community, he asked for larger support, science, like war, requiring sinews; he also reminded the audience that the Society was the only link between science in Tasmania and the rest of the world, and stated that the Society held considerable and more communication than was generally supposed with similar organisations in Europe, England, America, Canada, South Africa, Asia, and the other Australian colonies.

To His Excellency Sir R. G. C. Hamilton, K.C.B., LL.D., President of the Royal Society of Tasmania.

Sir,—On the eve of your departure from the colony we, the Council of the Royal Society of Tasmania, desire to express, on behalf of the Fellows, our warm and cordial appreciation of the deep and practical interest which your Excellency has ever taken in the work of this Society. That this interest has been real and unwavering is shown by the fact that during the entire term of your official connection with the colony, now nearly six years, you have never failed to preside at our monthly meetings, except on two occasions only, when circumstances rendered it impossible; and not only is the Society indebted to you for contributions to its proceedings, but it has been enriched by your very liberal and valuable donations of standard works to the library. It is, therefore, almost needless to say we deeply regret that these pleasant relations, which have so long existed, are about to be severed, though we may be allowed at the same time to express a hope that the Society may still have the great benefit of your co-operation as a corresponding member. It only remains for us to offer our best and heartiest wishes for your future, whether passed in an official or private life; and as Lady Hamilton has been a not unfrequent visitor at our meetings, we respectfully beg to join her name with yours when we now bid you farewell. We remain your Excellency's very obedient servants—

(Signed by the Council and secretary).

Mr. BARNARD, vice-president and senior member of the Society, said: Your Excellency and Lady Hamilton, by way of supplement to the address which has just been presented to Your Excellency by Dr. Agnew, I have now the pleasant and agreeable duty to perform on behalf of the Council and Fellows of the Royal Society, of offering for Lady Hamilton's acceptance a Tasmanian black opossum skin rug as a token of the personal respect and esteem in which she is held by the members of this Society. It is not too much to say of Lady Hamilton that she is a pattern of all the domestic virtues, and that during her residence in Tasmania she has, both by precept and example, exercised a beneficial influence upon society generally, and upon young people in particular, that is likely to prove of lasting effect. Utility and comfort, rather than ornament and show, have been studied in the selection of the souvenir now presented, and it is hoped that Lady Hamilton in her travels in other and far distant lands, and under less genial skies, when using the carriage rug, will often be reminded of her pleasant sojourn in our sunny island of Tasmania. It now remains only to convey to Lady Hamilton our best wishes for the health, happiness, and prosperity of herself and family, and to express our sincere regret that we have so soon to say farewell. (Applause.)

The PRESIDENT said: Vice-presidents and members of the Royal Society,—I can only express my heartfelt thanks to you for the address which has just been read. If anything can add to the pleasure with which I receive it it is that it has been read by my dear friend, Dr. Agnew—(applause)—whom we are all glad to see amongst us again. (Renewed applause.) You have kindly referred to Lady Hamilton in your address. I can only refer to your kind action in giving her this beautiful token of your regard, and leave her to acknowledge its receipt herself (Applause.) I will just say one word before sitting down. You have been good enough to say that you hope I will become a corresponding member of the Society. I shall certainly have much pleasure in doing so—(applause)—and if the wheel of fortune in its revolutions should ever bring me back here as a resident of Tasmania, I hope you will allow me to resume my work amongst you as a working member. (Loud applause.)

Lady Hamilton, who received an ovation on rising, said:—Vice-presidents and members of the Royal Society,—I am extremely obliged to you for the beautiful present you have given me this evening. To think that it should have been presented by the hand of Mr. Barnard, who 51 years ago was made a member of this society by Sir John Franklin, is, I feel, a great honour. I shall never forget, however far away, how very good the members of the Royal Society have been, not only to me, but to every other woman in Tasmania, in allowing us to come here and improve our minds amongst the valuable properties of such a society as this. (Loud applause.)

THE SOUVENIRS.

The address was full bound in scarlet Turkey Morocco, bevelled boards, extra elegant, tooled in the Italian style of ornamentation, with a gold line border on the outside, and a broad margin in gold tooling on the inside of the covers. On the side, lettered in gold, were the words:—"Presented to His Excellency Sir Robert G. C. Hamilton, K.C.B., LL.D., President of the Royal Society of Tasmania." The engrossing was an exceedingly neat piece of penmanship (the work of Mr. Albert Reid), the delineation of the church text characters being clear and with just sufficient ornamentation to produce a pleasing artistic effect. The address was encircled by two wreaths of Tasmanian flowers and berries, painted in water colours by Miss A. Hall and Miss V. Hall. Altogether it forms a work of art, and reflects great credit on the artists; particularly so is this the case with the binding, which was executed by Mr. T. Young (Messrs. J. Walch and Sons). The rug was skilfully made of picked black opossum skins of extra size, lined with blue cloth, and made by Mrs. Paget, furrier, Murray-street.

The whole of the arrangements in connection with the meeting were ably carried out under the direction of the secretary (Mr. A. Morton).

THE PRESIDENT'S ADDRESS.

His Excellency Sir Robert G. C. Hamilton, K.C.B., LL.D., delivered the following address:—

Fellows of the Royal Society of Tasmania,—

During the Session, which closes this evening, eight meetings have been held, and twenty-two papers have been read. The number of Fellows of the Society has been increased by 12, and the number of Corresponding Members by eight. The Society has sustained a loss by the death of Captain Shortt, R.N., who for 10 years held the post of

Meteorological Observer for Tasmania. Captain Shortt furnished this Society with many valuable notes. He was a regular attendant at our meetings and took part in our discussions, although the hour at which he made his evening observations necessitated his leaving generally before they were over. He was an accurate and careful observer, and his sound common sense in dealing with his observations rendered them of much practical use.

The papers submitted to the Society this session have been of considerable interest and value. Mr. J. Shirley, one of our corresponding members, furnished a list of the known Lichens of Tasmania, and the Rev. F. R. M. Wilson, F.L.S., of Victoria, another of our corresponding members, submitted a paper on "The Climate of Eastern Tasmania, indicated by its Lichen Flora." Mr. A. T. Urquhart furnished notes "On some Tasmanian Spiders," and Mr. A. Morton "On some Tasmanian Insects, Thyrmeleon Sp. and a Cicadia." Mr. T. Stephens, M.A., read "Some Notes on a Specimen of Orthoceratite from the Silurian Limestone at Railton, in the Mersey District." Professor Ralf Tate, F.G.S., who will be the next President of the Australasian Association for the Advancement of Science, furnished a paper on the classificatory portion and synonyms of the *Eaetoniella Rufilabria.* Colonel Legge submitted some notes "On the Occurrence of some Australian Cranes, *Ardiedæ*, in Tasmania;" "On the Destruction of Mutton Birds in the Straits Islands;" "Note on Voracity of the Kelp Fish;" and "On a Tasmanian Acanthiza (Bush Tit)." Mr. G. M. Thomson, F.L.S., of New Zealand, a corresponding member, furnished some "Notes on Tasmanian Crustacea, with description of a New Species;" and Mr. J. R. McClymont, M.A., some remarks concerning various means of encouraging the study of Natural History in Tasmania." Mr. A. J. Taylor, F.L.S., laid before us some "Notes on the Square-set System of Timbering in Mining at Zeehan and Dundas," and "On the use of the Woomera, or Throwsticks, by the Aborigines of Tasmania." Mr. A. B. Biggs submitted some "Remarks on Sir Robert Ball's paper read at the Hobart meeting of the Australasian Science Association, entitled "The Astronomical Explanation of a Glacial Period." From Mr. H. C. Russell, F.R.S., Government Astronomer of New South Wales, we had a most interesting and valuable paper "On the Proposed Leake School of Practical Astronomy," in which he recommended that the Leake bequest of £10,000 should be handed over to the Tasmanian University, who should establish a school of astronomy, and an observatory, to be called the Leake Observatory. This proposal is now before the Council of the University, and it is to be hoped that the trustees of the bequest and the university authorities will see their way to carry out Mr. Russell's suggestion. I think we all agree with him when he says, "It seems to me most fitting that the colony in which this noble bequest was made should be the first to take up and to benefit by its provisions." At our first meeting this session we had a paper from Mr. W. E. Shoobridge on "Tasmanian Apples in London." In this interesting paper, which gave rise to a good deal of discussion, Mr. Shoobridge deals with the effect of soil, irrigation, and climatic conditions in the production of apples, and with the best means of securing that they reach the English market in a perfect condition. An industry of this sort is always subject at starting to severe checks from a want of knowledge as to the conditions most suitable to its proper development, and careful and accurate observation in every detail are essential before such knowledge can be attained. But these difficulties will be overcome, and, in my view, there is a great future for this industry, which will in time become as stable an industry as is that of Australian frozen meat, and I believe it will be a source of much wealth to Tasmania in future. To-night we have had the pleasure of listening to an interesting paper, by Mr.

M. Rhys-Jones, on the Elgin Marbles in the British Museum, illustrated by views shown to us by means of limelight.

I have now referred to all the papers which have been laid before us this session, with the exception of those bearing on social and economic matters. These are, "Notes on the Natural Limits to Occupation on the Land," by Mr. R. M. Johnston, F.L.S.; "Artificial Obstructions to the Occupation of the Land," by Mr. A. J. Ogilvy; "What are the Conditions which determine the Just and Equitable Representation of the People?" by Mr. R. M. Johnston; and "Trades Unionism as a Factor in Social Evolution," by Mr. A. J. Taylor. The attention which is now being given on all sides to social and economic subjects has thus left its mark upon the work of our Society for 1892, and the papers enumerated above, and the discussions arising upon them, form a marked feature in this year's proceedings. While on the one hand I myself should be very sorry to see the Royal Society of Tasmania so far depart from the original intention of its founders as to develop into more or less of a debating society on social and economic subjects, on the other, to exclude a discussion of such subjects from a scientific standpoint would, in my view, be the greatest mistake this Society could make. As I ventured to say in my inaugural address to the Australasian Association for the Advancement of Science, which met in this city in January of this year: "There never was a time in the history of the world when there was a greater necessity than there is now for a wider and clearer conception of economic truths, for problems of the greatest import are pressing for solution. While, on the one hand, no adjustment of these problems based upon selfishness and individual aggrandisement, or which does not recognise *duties* as well as *rights*, can or ought to stand; on the other, there is no small danger that an unwise acceptance of some of the more advanced of what are commonly called socialistic views might lead to the motives of human energy and of human exertion being so lessened as materially to interfere with the progress and advancement of the human race. I am not one of those who apprehend catastrophe arising in the inevitable development of a new industrial and social system, but if catastrophe does arise, it will arise from want of knowledge, and not, as some fear, from the prevalence of any spirit of anarchy. A wider and sounder knowledge of economic truths will, however, in my humble judgment, in process of time, lead not only to a satisfactory solution of present social difficulties, but will tend to develop conditions under which culture will be brought more within the reach of all." Holding these views, as I do, most strongly, I should deeply regret if this Society, which is the centre of scientific life in Tasmania, should ever discourage the discussion of such subjects at its meetings, provided, of course, that these discussions are conducted in a scientific spirit.

But while I consider that the fullest use of the meetings of this Society should be made for the discussion of this branch of science, I am very anxious that the original intention of its founders should be carried out even more fully than it is at present. That was, as you know, to encourage investigation into the plant and animal life of Tasmania, and to obtain, as far as possible, faithful and trustworthy records of the interesting forms and laws under which mineral, plant, and vegetable existences exhibit themselves in Tasmania. With this view I strongly commend to the Society the plan proposed some time ago to the members, by Mr. A. J. Ogilvy, for mapping out the country into districts, and appointing an honorary representative of the Society in each. I believe something has already been done in this direction, but I strongly advise the Society to carry it out systematically. If a representative of the Society were appointed in each district, the residents in such district would know whom to approach with anything of interest, and from this representative the Royal Society would receive reports. Much useful information would thus be gained which might otherwise be lost.

At one of our meetings Mr. Leonard Rodway called attention to the necessity which exists for a complete handbook of the botany of Tasmania, and he is now actively engaged in compiling such a work. It is much needed, for the only two comprehensive works which exist on the subject, viz, Hooker's great work, "Flora Tasmaniæ," and "Flora Australiensis," by Baron Von Müeller and G. Bentham, which includes the whole Flora of Australia, are far beyond the means of many of our botanical students and collectors. I need not say that Mr. Rodway's praiseworthy and useful work has the hearty sympathy and support of our Society.

As I have now held the office of President of this Society since 1887, and as this is the last occasion on which I shall have the privilege of addressing you, I will briefly place before you what our tale of work has been for this period. We have had 127 papers read before the Society; of these there were 14 in Astronomy, five in Chemistry and Mineralogy, 20 in Geology and Palæontology, 58 in Biology and Botany, 13 in Geography, and 16 in Economic and Social Science and Statistics, and the paper we have heard this evening on the Elgin Marbles. Looking back over these six sessions, I think a good deal of work has been done in them, and that there has been no falling off in the health and vigour of the Society. I should have liked, had time permitted, to have referred specially to some of this work, but as I have passed it in review already in my annual addresses to you at the close of each session, it perhaps is scarcely necessary that I should go over the same ground again. I desire, however, this evening to invite your attention to some directions, outside of our own operations, but interesting to us as a Society, in which progress has been made while I have been your President. During that time the building in which we now are has been extended by the addition of a new wing. The foundation stone of this addition was laid by that good friend of the Museum and of the Royal Society, Dr. Agnew, on December 23, 1886, and I had the privilege of declaring it open on May 22, 1889. This increase in space has been of the greatest use, not only in enabling a better disposal of objects of interest to be made for exhibition, but also for the accommodation of the rapidly growing additions to the Museum collection which, without an increase of space, could not have been exhibited at all. But the great feature of the new wing was that it provided an Art Gallery. Many valuable works of art have been placed in this gallery on loan, and a considerable number of valuable presentations have recently been made to it. Among them, I would refer to a water-colour scene in Italy, presented by Sir Lambert Dobson; an oil painting, by E. J. Poynter, R.A.; and a water-colour by E. M. Wimperis, presented by Miss Ada Wilson; and a series of landscapes, depicting the scenery of the Western Highlands of Tasmania, by our celebrated local artist, Mr. W. C. Piguenit, presented by the Government. A large number of students avail themselves of the privilege of copying the works of art exhibited in the gallery, and there can be no question that a taste and love for art is being generated in our midst, which, as time goes on, must infuse some strain of its elevating and refining influence into the national character of the future. Merely to stroll through the gallery and look at its works of art has an elevating and refining tendency, and I am glad to know that the attendance, both at the Art Gallery and the Museum is steadily increasing. The Curator informs me that it now amounts to about 1,000 a week. It is not only in Hobart that progress has been made in this direction. At Launceston, also, a new Museum and Art Gallery have been established, which I had the privilege of declaring open on 29th April, 1891. This undertaking is as yet only in its infancy, but it is progressing most satisfactorily. It already has a large daily attendance, and it fulfils for the North of the Island the same functions that the Hobart Museum and Art Gallery are fulfilling for the South.

In technical education, a matter in which we, as a Society, are greatly interested, immense strides have been made during the time I have been your President. There are technical schools now in operation in Hobart, in Launceston, and even in some of the smaller towns in the island, and I understand that the fine Technical School building in Hobart, of which I laid the foundation-stone so recently as July 10, 1889, has now so large an attendance that its accommodation is seriously taxed. A separate department has been formed to deal with agricultural education, and we have now an Agricultural Council disseminating knowledge respecting agriculture in all its branches, a function which the experience of this Society shows to be so necessary for the progress and well-being of this dominant industry. The possibilities of expansion in this industry are great, but an essential condition of such expansion, in profitable directions, is a wider knowledge of the laws which Nature has established, and of their operation and application to our needs. Such knowledge it is the main function of the Agricultural Council to disseminate in our midst, and its work in this direction has the heartiest sympathy of our Society.

During the same period, too, the University of Tasmania has been founded, and although it is early yet to speak of what it has done, it has great days before it. The gentlemen charged with its administration seem to me to be going the right way to work. They are fully alive to the fact that you must walk before you can run, and that you do not require a miniature Oxford or Cambridge in Tasmania. They know that science teaching must occupy a more prominent place in their curriculum than it does in the curriculum of these ancient seats of learning, and they will not be deterred from utilising their University to meet the wants of the community by any consideration that in so doing they may be departing somewhat from the functions of the old Universities at Home. But I am glad to see indications of a determination on their part that their standard shall be high. In this they are right and wise. The time must come when Hobart will be a great educational centre of a united Australia, and the higher the standard in Tasmania is known to be, the sooner will its University attract the youth from the other colonies, who will get at its seat of learning an education and training at least equal to that their own Universities afford, while at the same time they will be laying in a store of health and vigour, which, in the battle of life, is second only in importance to education itself.

In addition to all these new agencies working steadily and continuously in the direction of educational progress, two events have occurred during my term of office whose influence has been strongly in the same direction. I refer to the Exhibition at Launceston, so successfully managed, which must have had a great effect in opening and enlarging the minds of the many thousands of our people who visited it, and to the meeting of the Australasian Association for the Advancement of Science, held in this city in January last. I can see throughout the country evidence of the healthy stimulus caused by that gathering, and it is to me personally, having had the honour of being its president, a matter of the utmost satisfaction that the meeting was an undoubted success. Out of this meeting sprang the Australasian Home Reading Union, which I believe will, in conjunction with our numerous literary and debating societies, exercise a continuous, and, I hope, an ever-increasing influence in developing a taste for instructive reading among our people, and in directing home study to definite ends.

The advancement all round during the time I have been here has been very marked. Living near the Domain, as I do, I am struck by the improvements constantly being made in it, still more beautifying that beautiful park. The means of access to objects of interest in the neighbourhood of the city have been greatly improved. Only two years ago a stranger might easily have lost his way in going up Mount Wellington, a journey which every stranger should make. Now there is an excellent track right to the summit, from which, as we all know, a glorious view is to be had. When I came to Tasmania I had to land from my steamer in a tender. Now the largest steamships afloat lie alongside of our wharves. At that time if I wanted to telegraph to England I had to pay 9s. 11d. a word. Now it is less than half that amount. Then a letter Home cost 6d. for postage; now the cost is 2½d.

But when I have been indulging in this vein in conversation lately, I have not unfrequently been met by the rejoinder, "True, there has been great advancement, but all that has come to an end, and the country is in a more depressed state than it has ever been before." I should be the last to make light of the present financial difficulties of the country. That a small community like ours should have to pay upwards of £300,000 a year, or about £2 a head for every man, woman, and child in the island, outside of our borders, for interest of money borrowed, at a time when our industries, out of the profits of which alone this payment can be made, are in a depressed condition, is a serious matter. But I see lights through the darkness. Your natural resources are great, and your productions must and can be increased. You have recently passed through a period of most unhealthy speculation in mines, and are suffering from its inevitable collapse. The "haste-to-be-rich" which such a time necessarily induces is, however, now being replaced by that honest industry which alone can make a country really prosperous. In a time of speculative excitement it is true that certain individuals may be enriched by the transfer of wealth from other individuals, who of course are so much the poorer, but the actual total production of wealth in the country is not increased by such transfer. On the contrary, there is a diminution of it, for the inevitable result of gambling in stocks and shares is that the energies of so many of the people are directed into nonproductive, instead of into productive, channels. Industries which yield a safe and certain, though a moderate, return for the labour expended upon them languish, or are put on one side altogether, while those who ought to be steadily developing the country's resources, and in this way securing their own comfort and happiness, as well as the prosperity of their country, are deluding themselves by the vain hope that by means of some lucky hit or fortunate speculative adventure they may relieve themselves of the necessity of honest hard work in securing a livelihood. Where one succeeds in this hope hundreds fail, yet still the spirit of gambling keeps the hope alive, so long as speculation is rife in a country, and the loser of to-day may look forward to being a winner to-morrow. All this is now happily being changed, but the change is not being effected without serious loss to the community, aggravated and intensified by the disastrous failure of a trusted local bank, the Bank of Van Diemen's Land, whose shameful mismanagement has caused widespread suffering ruin to many in our midst; a suffering and a ruin of which the end has by no means yet been reached. Still there are prospects of better times before us. It is true that the wealth of the country, judged by the present selling prices of the land and by the market quotations of various securities and undertakings, has fallen enormously, but our resources are just what they were. The real wealth is with us all the same, and the bone and sinew to make it available and to put it into a marketable shape. I have already referred to the possibilities of expansion in your fruit trade, and in your agricultural industries generally. But the mineral wealth of Tasmania will, I feel confident, be a most important factor in restoring her prosperity. It is most cheering to note that during a period of almost unexampled depression, not only is the output from our mines increasing, but much of the increase is coming from new districts altogether. With the restoration of confidence brighter times must come. I must not be understood as implying that the periods of prosperity and depression of any particular country are wholly dependent upon what passes in that country, for the ramifications of commerce are world-wide. There is no doubt in my mind that the collapse of Baring Brothers, who had, I believe, very little direct Australian connection, was a powerful factor in bringing about the general depression from which we, in common with many other parts of the world, are at present suffering, and is it quite conceivable that the first movement in the direction of prosperous times for us may come from the other side of the globe. Even as I write this address, a new light is arising out of the darkness, which can be dimly seen across the broad Pacific. The altered policy of America, of which we are now being daily informed by cable, gives us good grounds for hoping that at no distant time a reduction will be made in the duties charged on wool and tin which the United States take from us, and that thus the demand for these staple productions of Tasmania will be largely increased. Then, again, we are all looking forward to a federation of these colonies. Many regard this as distant. I believe it to be near. But near or distant when it does come it will be an enormous benefit to Tasmania, and by affording increased outlets for our products will so add to our prosperity that our national debt will sit much more lightly than it now does on our shoulders.

In conclusion, it is not only the material prosperity of a country which is benefited and advantaged by the operations of a Society like this, and by the other educational influences to which I have referred. Such agencies also have a direct tendency towards the moral elevation of the community. They instil in us a love of truth, for truth's sake, and perhaps insensibly, but none the less surely, they raise our standard of political, commercial, and social morality. I wish all these agencies in this country God-speed. And now I must bid you all farewell. I thank the Fellows of this Society for their unvarying personal kindness and consideration towards myself. I thank you, Mr. Barnard, for the support, as Vice-President, you have always given me. I thank the secretary, Mr. Morton, for the excellence of his arrangements in all matters connected with our meetings, and with the work of the Society generally, and for reducing to a minimum the more or less formal work of the President. I thank Mr. Johnston for the assistance he has always so readily rendered me, not alone in matters connected with this Society. I congratulate Tasmania on having a man of Mr. Johnston's genius in her community, whose splendid work on her geology reflects credit alike on the author and on the country to which he belongs; and I congratulate this Society on having, as one of its members, a man of Mr. Johnston's power and knowledge, able and willing to render you yeoman service. It will always be a source of satisfaction to me that I have had the privilege of filling for so long a time the office of your President, and I will carry back with me to the Old Country few associations more pleasant than those connected with the Royal Society of Tasmania.

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Zoology—Vol. 1. General introduction to zoological series of reports by Sir C. Wyville Thomson, F.R.S. I. Report on the Brachiopoda dredged by H.M.S. Challenger during the years 1873-76, by Thomas Davidson, F.R.S., F.L.S., F.G.S., V.P.P.S. II. Report on the Pennatulida dredged by H.M.S. Challenger, by Professor Albert V. Kölliker, F.M.R.S. III. Report on the Ostracoda, dredged by H.M.S Challenger during the years 1873-1876, by G. Stewardson Brady, M.D., F.L.S. IV. Report on the bones of Cetacea, collected during the voyage of H.M.S. Challenger in the years 1873-1876, by William Turner, M.B., Lond., F.R.S.S., L. and E. Professor of Anatomy in the University of Edinburgh. V. Report on the development of the green turtle (chelone iviridis Schneider), by William Kitchen Parker, F.R.S. VI. Report on the fishes procured during the voyage of H.M.S. Challenger in the years 1873-1876, by Albert Günther, M A., M D., Ph.D., F.R.S., Keeper of the Department of Zoology in the British Muesum.

Vol. II. I. Report on certain Hydroid, Alcyonarian, and Madreporaian Corals, procured during the voyage of H.M.S. Challenger in the years 1873-1876. By H. N. Moxley, M.A., F.R.S., Fellow of Exeter College. Oxford, late Member of the Civilian Scientific Staff of the Challenger Expedition. II. Report of the Birds collected during the voyage of H.M.S. Challenger in the years 1873-1876. By Phillip Lutley Sclater, M.A., Ph. D., F.R.S., F.L.S., F.G.S., F.R.G.S., Secretary to the Zoological Society of London.

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Vol. V. I. Report on the Ophiuroidea dredged by H.M.S. Challenger during the years 1873-1876, by Theodore Lyman. II. Some Points in the Anatomy of the Thylacine (Thylacinus cynocephalus), Cuscus (Phalangista maculata), and Phascogale (Pascogale calura), collected by H.M.S. Challenger during the years 1873-1876; with an account of the Comparative Anatomy of the Intrinsic Muscles and Nerves of the Mammalian Pes., by Dr. D. J. Cunningham, Professor of Anatomy in the Royal College of Surgeons, Dublin.

Vol. VI. I. Report on the Actiniaria, dredged by H.M.S. Challenger during the year 1873-1876, by Professor Richard Hertwig. II. Report on the Tunicata, collected during the voyage of H.M.S. Challenger during the years 1873-1876. Ascidiæ Simplices. By William A. Herdman, D.Sc., F.L.S., F.R.S.,E., Professor of Natural History in the University College, Liverpool.

Vol. VII. I. Report on the Anatomy of the Spheniscidæ, collected by H.M.S. Challenger during the years 1873-1876, by Morrison Watson, M.D., F.R.S., E., Professor of Anatomy in the Owens College, Manchester. II. Report on the Pelagic Heimptera, collected by H.M.S. Challenger during the years 1873-1876, by F. Buchanan White, M.D., F.L.S. III. Report on the Hydroida, dredged by H.M.S. Challenger during the years 1873-1876, first part, Plumularidæ, by G. J. Allman, LL.D., F.R.S., S.L., and E., M.R.I.A.,V.P.L.S., etc. IV. Report on the Specimens of the Genus Orbitolites collected by H.M.S. Challenger during the years 1873-1876, by W. B. Carpenter, C.B., M.D., LL.D., F.R.S., F.L.S., F.G.S., Corresp. Memb. Inst., France, etc.

Vol. VIII. I. Report on the Copepoda obtained by H.M.S. Challenger during the years 1873-1876, by George Stewardson Brady, M.D., F.R.S., F.L.S. II. Report on the Calcarea dredged by H.M.S. Challenger during the years 1873-1876, by N. Polejaeff, R.A. of the University of Odessa. III. Report on the Cirripedia collected by H.M.S. Challenger during the years 1873-1876, Systematic Part, by Dr. P. P. C. Hoek, Member of the Royal Academy of Science of the Netherlands.

Vol. IX. Text. Report on the Foraminifera, dredged by H.M.S. Challenger during the years 1873-1876. By Henry B. Brady, F.R.S., F.L.S., F.G.S., etc. Vol. IX. Plates.

Vol. X. I. Report on the Nudibranchiata collected by H.M.S. Challenger during the years 1873-1876. By Dr. Rudolph Bergh, physician of the General Hospital of Copenhagen. II. Report on the Myzostomida collected during the voyage of H.M.S. Challenger during the years 1873-1876. By Dr. L. Von Graff, Professor of Zoology in the College of Forestry, Aschaffenburg, Bavaria. III. Report on the Cirripedia, collected by H.M.S. Challenger during the years 1873-1876. Anatomical Part by Dr. P. P. C. Hoek, member of the Royal Academy of Science of the Netherlands. IV. Report on the Human Skeletons, collected during the voyage of the H.M.S. Challenger in the years 1873-1876. The Crania, by William Turner, M.B., LL.D., F.R.S., S.L.,and E. Professor of Anatomy in the University, Foreign Member of the Anthropological Society of Paris. V. Report on the Polyzoa, collected by H.M.S. Challenger during the years 1873-1876. The Cheilostomata, by George Busk, F.R.S., V.P.L.S., etc.

Vol. XI. I. Report on the Keratosa collected by H.M.S. Challenger during the years 1873-1876, by N. Polejaeff, R.A., of the University of Odessa. II. Report on the Crinoidea collected during the Voyage of H.M.S. Challenger during the years 1873-1876, the Stalked Crinoids, by P. Herbert Carpenter, D.Sc., Assistant Master at Eton College. III. Report on the Isopoda collected by H.M.S. Challenger during the years 1873-1876, the Genus Serolis, by Frank Evers Beddard, M.A. (Oxon.), F.R.S.,E., F.R.M.S., F.Z.S., M.B.O.U., Prosector of the Zoological Society of London

Vol. XII. Report on the Annelida Polychæta, collected by H.M.S. Challenger during the years 1873-1876, by William C.

McIntosh, M.D., L.R.C.S.,E., LL.D., F.R.S.,S.L. and E., F.L.S., C.M.Z.S., Soc. Psychol. Par. Soc. Honor, etc., Professor of Natural History in the University of St. Andrews.

Vol. XIII. I. Report on the Lamellibranchiata, collected by H.M.S. Challenger during the years 1873-1876, by Edgar A. Smith, F.Z.S., Assistant in the Zoological Department of the British Museum. II. Report on the Gephyrea, collected by H.M.S. Challenger during the years 1873-1876, by Dr. Emil Selenka, Professor in the University of Erlangen. III. Report on the Schizopoda, collected by H.M.S. Challenger during the years 1873-1876, by Professor G. O. Sars, of the University of Christiana.

Vol· XIV. I Report on the Tuincata collected during the voyage of H.M.S. Challenger during the years 1873-1876. Part II. Ascidæ Compositæ. By Wm. A. Herdman, D.Sc., F.L.S., F.R.S.,E., Professor of Natural History in University College, Liverpool. II. Report on the Holothurioidæ, dredged by H.M.S. Challenger during the years 1873-1876. Part II. By Hjalmar Théel.

Vol. XV. I. Report on the Marseniadæ collected by H.M.S. Challenger during the years 1873-1876. By Rudolph Bergh, physician to the General Hospital of Copenhagen. II. Report on the Scaphopoda and Gasteropoda, collected by H.M.S. Challenger during the years 1873-1876. By the Rev. Robert Boog Watson, B.A., F.R.S.,E., F.L.S., F.G.S., etc. Ehrenmitglied des Naturwissenschaftlichen Vereins Lüneburg, minister of the Free Church of Scotland, Cordross. III. Report on the Polyplacophora collected by H.M.S. Challenger during the years 1873-1876. By Alfred C. Haddon, M.A., M.R.I.A., Professor of Zoology, Royal College of Science, Dublin.

Vol. XVI. I. Report on the Cephalopoda, collected by H.M.S. Challenger during the years 1873-1876, by William Evans Hoyle, M.A. Oxon., M.R.C.S., Naturalist on the Editorial Staff of the Challenger Reports. II. Report on the Stomatopoda, collected by H.M.S. Challenger during years 1873-1876, by W. K. Brooks, Associate Professor of Zoology and Director of the Marine Laboratory of the John Hopkins University, Baltimore, U.S.A. III. Report on the Reef Corals, collected by H.M.S Challenger during the years 1873-1876, by John I. Quelch, B.Sc., Lond., late Assistant British Museum, Curator of the British Guiana Museum, George Town, Demerara. IV. Report on the Human Crania and other Bones of Skeletons, collected during the voyage of the H.M.S Challenger in the years 1873-1876, Second Part, by Sir William Turner, Knt., M.B., LL.D., F.R.S., S.L. and E. Professor of Anatomy in the University of Edinburgh, Foreign Member of the Anthropological Society of Paris.

Vol. XVII. I. Report on the Iopoda collected by H.M.S. Challenger during the years 1873-1876; second part. By Frank Evans Beddard, M.A., Oxon., F.R.S.,E., F.Z.S., Prosector of the Zoological Society of London. II. Report on the Brachyura collected by H.M.S. Challenger during the years 1873-1876. By Edward J. Miers, F.Z.S., F.L.S., of the British (Natural History) Museum. III. Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876; second part. By George Busk, F.R.S., V.P.L.S.

Vol. XVIII. Report on the Radiolaria collected by H.M.S. Challenger during the years 1873-1876, by Ernst Haeckel, M.D., Ph.D., Professor of Zoology in the University of Jena, first part. Porulosa Spumellaria and Acantharia. Vol. XVIII. Report on the Radiolaria collected by H M S. Challenger during the years 1873-1876, by Ernst Haeckel, M.D., Ph.D., Professor of Zoology in the University of Jena, second part, Osculosa (Nassellaria and Phæodaria). Vol. XVIII. Report on the Radiotaria collected by H.M.S. Challenger during the years 1873-1876, by Ernst Haeckel, M.D., Ph.D., Professor of Zoology in the University of Jena. Plates.

Vol. XIX. I. Report on the Nemertea collected by H.M.S. Challenger during the years 1873-1876, by Dr. A. A. W. Hubrecht, LL.D., C.M.Z.S., Professor of Zoology in the University of Utrecht. II. Report on the Cumacea collected by H.M.S. Challenger during the years 1873-1876, by Professor G. O. Sars, of the University of Christiana, III. Report on the Phyllocarids collected by H.M.S. Challenger during the years 1873-1876, by Professor G. O. Sars, of the University of Christiana. IV. Report on the Pteropoda collected by H.M.S. Challenger during the years 1873-76, first part, by Paul Pelseneer, D.Sc., Brussels.

Vol. XX. I. Report on the Monaonida collected by H.M.S. Challenger during the years 1873-1876, by Stuart O. Ridley, M.A., F.L.S., late assistant in the Zoological Department of the British Museum, and Arthur Dendy, B.Sc., F.L.S., assistant in the Zoological Department of the British Museum. II. Report on the Myzostomida (supplement), collected by H. M.S. Challenger during the years 1873-1876, by Dr. L. Von Graff, Professor in the University of Graz, Austria. III. Report on Cephalodiscus Dodecalophus, a new type of the Polyzoa, procured on the voyage of H.M.S. Challenger during the years 1873-1876, by William C. McIntosh, M.D., LL.D., F.R.S., etc., Professor in the University of St. Andrew's.

Vol. XXI. Report on the Hexactinellida collected by H.M.S. Challenger during the years 1873-1876, by Dr. F. E. Schulze, Professor of Zoology in the University of Berlin. Plates. Vol. XXI. Report on the Hexactinellida collected by H.M.S. Challenger during the years 1873-1876, by Dr. F. E. Schulze, Professor of Zoology in the University of Berlin. Text.

Vol. XXII. Report on the Deep Sea Fishes collected by H.M.S. Challenger during the years 1873-1876, by Albert Gunther, M.A., M.D., Ph.D., F.R.S. Keeper of the Department of Zoology in the British Museum.

Vol. XXIII., I. Report on the Pteropoda collected by H.M.S. Challenger during the years 1873-1876. Part II. The Thecosomata, by Paul Pelseneer, D.Sc., Brussels. II. Report on the Pteropoda collected by H.M.S. Challenger during the years 1873-1871. Part III. Anatomy, by Paul Pelseneer, D.Sc., Brussels. III. Report on the Hydroida collected by H.M.S. Challenger during the years 1873-1876. Part II. Tubularinæ, Corymorphinæ, Campanularinæ, Sertularinæ, and Thalamophora, by Professor G. J. Allman, M.D., LL.D., F.R.C.S.,I., F.R.S., S.L. and E.M.R.I.A., C.M.Z.S., Mem. Roy. Danish Acad. Sci., etc. IV. Report on the Entozoa collected by H.M.S. Challenger during the years 1873-1876, by Dr. O. von Linstow, of Gottingen. V. Report on the Heteropoda collected by H.M.S. Challenger during the years 1873-1876, by Edgar A. Smith, F.Z.S., assistant in the Zoological Department of the British Museum.

Vol. XXIV. Plates, report on the Crustacea Macrura, dredged by H.M.S. Challenger during the years 1873-1876, by C. Spence Bate, F.R.S., etc.

Vol. XXIV. Text, Report on the Crustacea Macrura, dredged by H.M.S. Challenger during the years 1873-1876, by C. Spence Bate, F.R.S., etc.

Vol. XXV. Report on the Tetractinellida collected by H.M.S. Challenger during the years 1873-1876. By W. J. Sollas, M.A., D.Sc., LL.D., Dublin, Professor of Geology and Mineralogy in the University of Dublin, late Fellow of St. John's College, Cambridge.

Vol. XXVI. I. Report on the Crinoidea collected during the voyage of H.M.S. Challenger during the years 1873-1876. Part II. The Comatulæ. By P. H. Carpenter, D.Sc., F.R.S., F.L.S., Assistant Master at Eton College. II. Report on the Seals collected during the voyage of H.M.S. Challenger in the years 1873-1876. By Sir William Turner, Knt., M.B., LL.D., F.R.S., and S.L.V.E., Professor of Anatomy in the University of Edinburgh, Member of the General Medical Council. III. Report on the Actiniaria dredged by H.M.S. Challenger during the years 1873-1876. (Supplement.) By Professor Richard Hertwig.

Vol. XXVII. I. Report on the Anomura collected by H.M.S. Challenger during the years 1873-1876, by Professor J. R. Henderson, M.B., F.L.S. II. Report on the Anatomy of the Deep-Sea Mollusca collected by H.M.S. Challenger during the years 1873-1876, by Professor Paul Pelseneer, D.Sc. (Brussels). III. Report on Phoronis Buskii, N.Sp., dredged by H.M.S. Challenger, 1873-1876, by Professor W. C. McIntosh, M.D., LL.D., F.R.S., etc. IV. Report on the Tunicata collected by H.M.S. Challenger during the years 1873-1876, Part III., by Professor W. A. Herdman, D.Sc., F.L.S., F.R.S.E.

Vol. XXVIII. Report on the Siphonophoræ collected by H.M.S. Challenger during the years 1873-1876. By Ernst Haeckel, M.D., Ph.D., Hon. F.R.S.,E., etc., Professor of Zoology in the University of Jena.

Vol. XIX. Report on the Amphipoda collected by H.M.S. Challenger during the year 1873-1876. By Rev. Thomas R. R. Stebbing, M.A. Plates.

Vol. XXIX. Text first half. Report on the Amphipoda collected by H.M.S. Challenger during the years 1873-1876. By Rev. Thomas R. R. Stebbing, M.A.

Vol. XXIX. Text second half. Report on the Amphipoda collected by H.M.S. Challenger during the years 1873-1876. By Rev. Thomas R. R. Stebbing, M.A.

Vol. XXX. Plates, report on the Asteroidea collected by H.M.S. Challenger during the years 1873-1876, by W. Percy Sladen, F.L.S., etc. Vol. XXX. Text, report on the Asteroidea collected by H.M.S. Challenger during the years 1873-1876, by W. Percy Sladen, F.L.S., etc.

Vol. XXXI. I. Report on the Alcyonaria collected by H.M.S. Challenger during the years 1873-1876, by Professor E. Percival Wright, M.D., etc., and Professor Th. Studer, M.D. II. Report on the Pelagic

Fishes collected by H.M.S. Challenger during the years 1873-1876, by Albert Gunther, M.A., M.D., Ph.D., F.R.S., keeper of the Department of Zoology in the British Museum. III. Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876, by Arthur A. Waters, F.L.S., F.G.S.

Vol. XXXII. I. Report on the Antipatharia collected by H.M.S. Challenger during the years 1873-1876, by Geo. Brook, F.L.S., F.R.S.,E. II. Supplementary Report on the Alcyonaria collected by H.M.S. Challenger during the years 1873-1876, by Professor Th. Studer, M.D. III. Report on the Deep-Sea Keratosa collected by H.M.S. Challenger during the years 1873-1876, by Professor Ernst Haeckel, M.D., Ph.D., Hon. F.R.S.,E.

Narrative Vol. I. First Part and Second Part. Narrative of the cruise of H.M.S. Challenger, with a general account of the scientific results of the Expedition, by Staff-Commander T. H. Tizard, R.N.; Professor H. N. Moseley, F.R.S.; Mr. J. Y. Buchanan, M.A.; and Mr. John Murray, Ph.D., members of the Expedition.

Narrative Vol. II. Magnetical Observations made during the voyage by Sir Frederick Evans, K.C.B., F.R.S., Hydrographer.

Narrative Vol. I. Second Part. Narrative of the Cruise of H.M.S. Challenger, with a general account of the Scientific Results of the Expedition, by Staff-Commander T. H. Tizard, R.N., Professor H. N. Moseley, F.R.S., Mr. C. Y. Buchanan, M.A., and Mr. John Murray, Ph.D., members of the Expedition. Partly illustrated by Dr. J. J. Wild, artist to the Expedition.

Vol. II. I. Memorandum on the Magnetical Observations made during the voyage, by Sir Frederick Evans, K.C.B., F.R.S., Hydrographer. II. Magnetical Instructions, 1872, addenda to Magnetical Instructions of 1872. III. Abstract of Magnetical Observations during the voyage. IV. Abstract of Magnetical Observations made at land stations, prefaced with descriptive references to the positions (observation spots) of the instruments. V. Abstracts of Variations of the Compass observed at Sea. VI. Abstract of Observations with Fox Compasses. VII. Memorandum of the Meteorological Observations made during the voyage, by Staff-Commander Tizard, R.N. VIII. Abstract of Meteorological Observations, appendix A—The Pressure Errors of the Challenger's Thermometers, by Professor P. G. Tait, M.A., Sec. R.S.,E., Professor of Natural Philosophy in the University of Edinburgh. Appendix B—On the Petrology of St. Paul's Rocks (Atlantic), by Professor A. Renard, F.G.S.

Physics and Chemistry, Vol. I. I. Report on Researches into the Composition of Ocean Water, collected by H.M.S. Challenger during the years 1873-1876, by Professor William Dittmar, F.R.S. II. Report on the Specific Gravity of Samples of Ocean Water, observed on board H.M.S. Challenger during the years 1873-1876, by T. Y. Buchanan, Esq., M.A., F.R.S.,E. III. Report on the Deep Sea Temperature Observations of Ocean Waters, taken by the officers of the expedition during the years 1873-1876. Vol. II. I. Report on some of the Physical Properties of Fresh Water and Sea Water, by Professor P. G Tait. II. Report on Atmospheric Circulation, based on the observations made on board H.M.S. Challenger during the years 1873-1876, and other Meteorological Observations, by Alexander Buchan, M.A., LL.D. III. Report on the Magnetical Results obtained by H.M.S. Challenger during the years 1873-1876, by Staff-Commander E. W. Creek, R.N., F.R.S. IV. Report on the Rock Specimens Collected on Oceanic Islands during the voyage of H.M.S. Challenger during the years 1873-1876, by Professor A. Renard, LL.D., M.D., F.G.S., Hon. F.R.S.,E., etc., of the University of Ghent, Belgium.

Botany, Vol. I.—I. Report on present state of knowledge of various Insular Floras, being an introduction to the first part of the Botany of the Challenger Expedition. By William Botting Hemsley, A.L.S. II. Report on the Botany of the Bermudas and various other islands of the Atlantic and Southern Ocean. First part. By William Botting Hemsley, A.L.S. III. Report on the Botany of the Bermudas and various other islands of the Atlantic and Southern Ocean. Second part. By William Botting Hemsley, A.L.S. IV. Report on the Botany of Juan Fernandez, the South-Eastern Moluccas, and the Admiralty Islands. By William Botting Hemsley, A.L.S. Vol. II. —Report on the Diatomaceæ, collected by H.M.S. Challenger during the years 1873-1876. By Conte Abate, Francesco Castracane-degli Antelminelli, Rome.

Vol. II. Botany. Report on the Diatomaceæ. By Conte Francesco Castracane-degli Antelminelli. (Plates.)

NOTES ON THE NATURAL LIMITS TO OCCUPATION ON THE LAND.

By R. M. Johnston, F.L.S.

The number of persons that may be employed upon the land varies with the country, with the form of cultivation, and with the degree of civilisation. But whatever the civilisation may be, there are natural limits to occupation on the land which bar the introduction of more than a certain number. The natural conditions which principally determine these limits are:—(A.) The total extent of land surface of the particular country. (B.) The degree of fertility and the extent of land open to hunting wild animals, or gathering natural vegetable roots or fruits; cultivation for pasturage only; cultivation for either crops or pasturage. (C.) Knowledge and capital as factors in determining and employing the best methods for extracting the greatest amount of produce from a definite area. (D.) The absolute number of hands necessary to cultivate a given area in any form, beyond which limit human labour is wasted in fruitless effort or in positive idleness. (E.) The proportion of cultivable area already occupied. If, in addition, we employ the indices *m*, *e*, and *n* as indicating maximum, medium, and minimum of each condition, we may express by simple formulæ the conditions which determine the largest (D^m) and smallest (D^n) number of hands which can find occupation on the land; always assuming that their time is wholly occupied within the field of their own division of labour.

We are now able to express definitely the conditions which determine the *maximum* (D^m), *medium*, and *minimum* (D^n) number of hands that it would be necessary to employ upon the land according to the existing conditions under which agricultural and pastoral pursuits are carried on in the United Kingdom.

The Maximum number of hands employed upon the land could only occur under the following conditions:—

$$A^m \times B^m \times C^n = D^m$$

The Minimum number could alone be employed under the opposite of this condition, viz.:—

$$A^n \times B^n \times C^m = D^n$$

But it never happens that a country as a whole can devote all its cultivable lands to one form of cultivation, say, crops from tilled lands. The following proportions show what obtains in five great countries in Europe:—

PROPORTION PERCENTAGE, TOTAL AREA IN CULTIVATION.

—	Tillage.	Pasturage.	All cultivated.	Hands per 100 acres in cultivation.
United Kingdom ...	43·56	56·44	100·00	5·38
France	86·96	13·04	100·00	7·17
Russia	39·23	60·77	100·00	7·88
Germany	58·40	41·60	100·00	12·19
Belgium	82·46	17·56	100·00	17·91
Five Countries ...	53·79	46·21	100·00	8·22

From this analysis we can perceive that there is a variation in the hands employed per 100 acres, ranging between 5·38 per cent. in the United Kingdom to 17·91 in Belgium. The tilled lands requiring a larger proportion of hands, account for the larger number employed per 100 acres in some countries; but against this must be placed the reduction in the hands employed, effected by the introduction of machinery and improved methods of culture—when all other things are equal. The space limit to occupation on the land, however, can only affect countries that are already densely populated and whose land area relatively is limited. Let us, therefore, apply this method to a particular country, say, the United Kingdom, for the purpose of ascertaining:—

1. The maximum number of hands that could find employment upon the land, supposing it was conceivable to bring the total area into cultivation.

2. The maximum number that could find employment on the more probable supposition that only 75 per cent. of the area could possibly be utilised.

3. The number of years in which the full limit would be reached supposing it conceivable to cultivate the whole area of the country including sites of dwellings in towns, villages, and cities, and lake and mountain areas.

4. The number of years in which the full limit would be reached, supposing it probable that no more than 75 per cent. of the total area could be brought under cultivation.

Then let A=Total area in acres = 77·80 million acres.

H=The number of hands required to cultivate each 100 acres according to existing conditions=5·35 hands.

R=Average natural rate of increase of Rural Population=say 1·25 per year.

C=The actual area already in cultivation in (1840)=43·80 million acres.

N=The number of hands already employed in 1840 in cultivating the land=3·400 million hands.

N^a=Ditto ditto in 1881=2·561 million hands.

The answers to queries 1, 2, 3, and 4 would be as follows:—

Query (1.) $\therefore \frac{AH}{100} = X$ or max. number of hands or =Ans. (1)=4·162 millions.

(2.) $\therefore \frac{\left(\frac{75\,A}{100}\right)}{100} \times H = Y$ or max. number of hands, or = Ans. (2) = 3·122 millions.

(3.) $$\therefore \frac{\log. X - \log. N}{\log. R} = \frac{\log. 4{\cdot}162{\cdot}000 - \log. 3{\cdot}400{\cdot}000}{\log 1{\cdot}25}$$
= 16·28 years or year 1856.

(4.) $$\therefore \frac{\log. Y - \log. N^a}{\log R} = \frac{\log. 3{\cdot}122{\cdot}000 - \log. 2{\cdot}561{\cdot}000}{\log. 1{\cdot}25}$$
= 15·94 years, or year 1896.

$$\therefore \frac{\log. X - \log. N}{\log. R} = \frac{\log. 4{\cdot}162{\cdot}000 - \log. 2{\cdot}561{\cdot}000}{\log. 1{\cdot}25}$$
= 39·09 years, or year 1929.

It has thus been demonstrated that the ordinary growth by natural increase of the agricultural population of the United Kingdom of 1841 (if migration was prevented by placing them on the land still uncultivated) would fully stock the whole of its land area of every description in 16·28 years later; that is in the year 1856, or 36 years ago. Starting with the agricultural population of 1881, the same rate of natural increase, under similar conditions, would fully stock 75 per cent. of its land surface in the year 1896, or four years hence; and even if we conceive what is impossible, that its total area was open to cultivation, this same natural increase would fully stock land occupations in the year 1920.

It is clear, therefore, that employment on the land in the United Kingdom is bound in within very narrow limits by space—one of the most formidable of all natural limits—and no alteration in the rate of remuneration of the agricultural labourer, nor improvement in his condition, can affect this limit in the slightest degree. But in addition to the space limit, the number of hands necessary to cultivate a given area, or produce a definite quantity of produce, there is a gradually contracting limit brought about by natural forces, such as steam, electricity, and improvements in labour-saving machinery. Thus the same area in 1881 was cultivated in a higher degree, and with better results, than in 1841, with a reduction in the hands employed equivalent to 31·06 per cent. Since 1841 the added force of steam, as an auxiliary to human labour in the United Kingdom alone, and there utilised in the transport of materials and in various other ways, is estimated to be equivalent to the manual force of 103 millions of workmen, or fully six times the manual force of the total number of breadwinners of the United Kingdom at the present moment. It is not surprising, therefore, that agricultural hands per 100 acres should have decreased from 7·76 in 1840 to 5·35 in the year 1881; and that these combined causes should of necessity compel a regular stream of migration from rural districts to urban centres or to other countries; and so long as a healthy condition exists in rural districts (unmistakably indicated always by a high rate of natural increase) such migration is inevitable. According to calculations made by Mr. Mulhall, in the United States 9,000,000 hands raise nearly half as much grain as 66,000,000 hands in Europe. Thus it appears that for want of implements or proper machinery there is a waste of labour in Europe equal to 48,000,000 of peasants. In other words, one farm labourer in the United States is worth more than three in Europe. This state of affairs in Europe, however, is altering for the better each year. Since 1840, owing to improvements in implements and machinery, tillage has become more productive, and grain has become cheaper. From the same authority we learn that "in 1840 each peasant produced about 75 bushels of grain; in 1860 the average was 87, and in 1887 it had risen to 114; that is, two men now produce more grain than three did in 1840." From these observations we are able to understand that a smaller number of hands employed in agriculture is no indication of smaller produce. Take the results of two periods in the United Kingdom, 1840 and 1887, and we at once perceive that the tendencies upon the whole are beneficial—not injurious.

—	1840	1887	Percentage Increase or Decrease since 1840.	
			Increase.	Decrease.
Total population Millions No.	26·71	37·08	38·86	—
Agricultural hands ,, ,,	3·40	2·56	—	24·70
Other occupations ,, ,,	7·96	14·16	77·89	—
Total acreage under crop ... ... ,, Acres	22·00	21·00	—	4·55
Total under all forms of cultivation ... ,, ,,	43·80	47·88	9·19	—
Agricultural capital per hand ... ... ,, £	579	893	54·23	—
Agricultural products per hand... ,, £	65	97	49·23	—
Agricultural hands per 100 acres in crop... ... ... No.	15·45	12·19	—	21·10
Ditto per 100 acres in total cultivation ... No.	7·76	5·35	—	31·06
Wheat consumed per head ... ... lbs.	255	354	38·82	—
Meat consumed per head ... ... lbs.	87	109	25·29	—
Price of wheat per ton £	16·60	8·15	—	50·90
Capital wealth ... millions £	4,100	9,400	129·30	—
Horse-power of steam used as a motive power .. .. No.	600,000	9,200,000	1,433	—
Paupers per 1,000 persons ... ... No.	57·40	25·80	—	55·05

Nothing could more plainly reveal the general tendency of modern agriculture than these figures. It shows clearly, so far as the United Kingdom is concerned, that progress in improved modes of cultivation means:—Increased capital, increased products, cheaper food, increase of hands in other occupations, and a gradual decrease in the hands employed in agricultural pursuits, associated with a general decrease in the amount of pauperism. Employment upon the land, therefore, is lessened relatively by every advance made in the modes of culture, and is blocked absolutely so far as many populous countries are concerned by limits of space available for cultivation of any kind. Unless, therefore, a country like the United Kingdom takes a backward step in mode of cultivating the land, she cannot, while foreign products are of necessity admitted freely, place more than 5·35 hands upon each 100 acres in cultivation. No legislation under such conditions, made with the view of giving facilities for land ownership, can affect the numbers that may be employed. It is conceivable that the lot of the worker may by such means be ameliorated or improved, but legislation within a freetrade border cannot enlarge the field of employment for the agricultural labourer. Nor under any circumstances whatever can legislation increase the number of agricultural hands without loss and injury to the people as a whole.

In conclusion, let me not be supposed to indicate by these observations that the lessening numbers of persons employed on the land in such a country as the United Kingdom is to be regarded as a matter to be deplored. On the contrary, I regard it as an index of advance in civilisation. If the food and raw products necessary for man's needs and satisfactions could be miraculously produced without the agency of a single labourer, mankind would be enriched, not impoverished; for there would then be so much more labour force available for the creation of comforts and satisfactions, in such cheapness and abundance, that all men might possess and enjoy them in a degree now only possible to a few rich individuals. What is wanted, therefore, in countries passing through a transition of the kind referred to is, not to place any check upon free migration and other movements which now act as safety-valves to congested fields of labour, but rather to increase the facilities for transfer from those places and those occupations where pressure of competition for employment is greatest. It is the obstruction which natural and artificial barriers offer to transfer from blocked areas and blocked occupations that causes the so-called congestion of labour in crowded centres of population, and any discovery which would remove such barriers would mark a new era in the progress of civilised communities.

DISCUSSION.

Hon. N. J. BROWN, in speaking to the paper, said he could not presume to criticise the able and interesting paper they had just listened to. He would like to read it carefully before making any remark upon it, but as he had been invited to open a discussion of it, he would venture to express one or two ideas that had occurred to him on the spur of the moment. There was just one point which it seemed to him Mr. Johnston had rather omitted to give prominence to, and that was the competition which a country like Great Britain, and he might say other European countries also, had to contend with, more especially in recent years, by the employment of labour sustained at a very small expense as compared with the labour in the countries he had more especially dealt with. Any change in the direction of increased cost of production of cereals abroad would surely increase the quantity that could be profitably produced at home; and, consequently, the number of people employed in such production. There was no doubt, looking at the matter broadly, that there was prevalent a very great delusion in the minds of very many people who were not acquainted with the conditions under which land was cultivated as to the extent to which it might be profitably occupied, and if so far the paper read would have the effect of dissipating that illusion, he was quite sure Mr. Johnston would have done good service not only to this community, but to other communities also. There was no doubt a feeling abroad which was expressed by a prominent politician some two or three years ago that the salvation of the working population of Great Britain might be worked out by presenting each labourer with three acres and a cow, and he thought that one object of the paper was to some extent to remove delusions such as that from the popular mind. They knew that in this colony in past years it had been exceedingly profitable for people to take up 200, 300, or 400 acres, and devote themselves exclusively to the cultivation of grain. But other conditions had now come in with the cultivation of the soil in the other colonies, and therefore they found a great deal in what Mr. Johnston had said which could be brought home to themselves. One other point he would like to mention in connection with this subject. He referred to the fact by the increase of population it is estimated by a reliable authority the world required annually an increase of 30 millions of bushels of wheat, and as the production of wheat was gradually falling off, owing to the continued reduction in price, it was thought by those competent to judge that within the next few years there would be a considerable increase in the price of wheat. If that were so, and the calculation he had mentioned rested upon a solid foundation, it certainly must to a very considerable extent modify the views which Mr. Johnston and others took as to the prospects of the cultivation of land for the production of cereals even in the United Kingdom. He would only add that their cordial thanks were due to Mr. Johnston for introducing the subject to their notice, and for the manner in which he had dealt with it.

Mr. JOHNSTON pointed out, in reply, that what he spoke about was the natural limits to the occupation of the land. Of course, the space limit could not apply to these colonies, and he hoped it would be very long before it could apply here. It was in England, and places of a like nature, in which the space limit, as a factor, comes immediately into operation in determining the number of hands that may be employed on the land. With regard to the proposals to give each agricultural labourer a bit of land to cultivate for himself, and so augment his income obtained otherwise by working for large farm employers, he hoped it might ameliorate his condition, but he feared that he could not permanently retain this advantage, as the tendency of competition would make this very advantage a lever to depress ordinary wages.

HIS EXCELLENCY, in moving a vote of thanks to the gentlemen who had contributed papers, said he had listened to very many interesting papers, but he did not think he ever listened to any paper with such interest as the one delivered by Mr. Johnston. It was a subject he had thought a good deal on himself. He had never heard or seen it treated in the same way as Mr. Johnston had done, and he hoped when completed the paper would have a very wide circulation indeed. In an article in a recent number of the *Nineteenth Century*, Mr. Johnston referred to the point slightly; but he had dealt with it that night in such a strong way that he had really advanced the scientific basis of the subject. Of course, there was a great deal to be said on the other side; but he held that Mr. Johnston had really taken a step forward in the consideration of the subject. As regarded Mr. Taylor's paper, he was sure they had all listened to it with great interest. The explanation he had given was very clear, and he had no doubt his object would be fulfilled if the general attention of the mining public was directed both to the advantages and drawbacks of this description of timbering. (Applause).

WHAT ARE THE CONDITIONS WHICH DETERMINE THE JUST AND EQUITABLE REPRESENTATION OF THE PEOPLE?

By R. M. Johnston, F.L.S.

To secure a just and equitable representation of the people in Parliament is a matter which has at all times engaged the attention of thoughtful, practical legislators, and of great thinkers. That the idealist should be far in advance of the practical legislator is what we must naturally expect; for in their ideal schemes of "The Best Form of Government," or "The Best Form of Representation," the former may easily overlook or surmount obstacles by assumptions which are not open to the practical legislator who attempts to reduce any ideal to practice. If knowledge and justice were synonymous, there would be less difficulty as regards the attainment of an ideally perfect representation, for this might be secured by basing the electorate upon some common fixed minimum standard of education. But the practical legislator cannot entertain this dream, for his experience has too well taught him that selfishness and injustice are not eliminated by greater intelligence, nor is the sense of justice necessarily absent where the intelligence is small. An education standard, therefore, only helps us a very little way towards securing a basis for the formation of a just representation of the people. Indeed, another chapter in history is no longer necessary to us to demonstrate that the great barrier to just representation in the future is *immediate self-interest*, not *ignorance*. Self-interest is not always base, in the sense of being restricted to the individual, although it is always distinguished as the centre of those graduated rings of sympathies and interests which are in greatest harmony with those of the individual. These rings of sympathies, however, are themselves variable and complex, and sometimes conflict with each other.

The interests and sympathies which most strongly affect all individuals in common are approximately related to the individual in the following order, which, in a general way, correspond with a diminution of intensity, viz.:

					Public Interests.
1.		Individuals of the Family Group.			Invariable, and simple within the Family Group.
2.	Family	Family.			Practically the same.
3.	Head of Family.				Ditto, ditto.
4	National	Locality Interests.	Class Interests.	Moral Sympathies.	Interests variable and often conflicting in the same individual.

From this analysis we perceive that an ideally just representation of the people must be based upon the family, whose interests from a social point of view are in common, and are usually centred in *one* person, who by nature and affection stands as their natural guardian and representative to the outer world. At this stage the *foe* to just representation at a later stage is rendered comparatively harmless by the short range yet locally dominating altruistic attributes, such as the spontaneous love, affection, friendship, or powerful sense of duty, always more or less active, either in subduing the narrower forms of selfishness within the family group, or in so modifying its influence as to become beneficial, not harmful, to the family interest as a whole.

Any scheme of representation, therefore, which would aim at penetrating the solidarity of the family by proffering separate electoral rights to each of its existing component members would do more harm than good, for it would destroy the true foundation upon which good government rests, viz., the altruistic virtues evoked and fostered within the family circle. The question of *Female Suffrage* is reduced to a small compass when considered from this point of view.

The natural guardian of each family is also, as a rule, the breadwinner, and therefore the *naturally elected* representative of the dependent wife, child, or relative. It is manifest also that artificial representation should only begin where natural representation ends, *i.e*, in the natural representative of the *family*. It excludes the dependants, not merely because they are females, or because the male dependants are under 21 years of age, but mainly because all such are naturally comprehended in their natural representative—the householder. There is no artificial determination of what constitutes a householder. Whatever natural condition exists which calls one person out to be regarded as the head of the family group suffices—whether it be the father, widowed mother, elder brother, or elder sister—so long as such one is regarded by the family group as the nominal head or guardian. The natural unit of the electorate of any population is the "Householder"—not "males 21 years of age and over." The males of a population, 21 years of age and over, as such have no natural right to be singled out from women and children as representative electors of the community other than the savage one of being the *stronger*. Of course there are reasons, if not rights, why single men of 21 years and over may have some claim to electoral privileges, *e.g.*: 1. They may not be represented by any natural guardian or householder. 2. They may be independent breadwinners, and thus independently contribute to the taxation necessary for the government of the country. 3. *They may specially be drawn upon to defend the State in the case of war or disturbance* *to the peace of the community*. But the two first reasons also apply to all single adult female breadwinners, who are neither householders nor represented by natural guardians. It is the third reason which alone gives a special claim to single adult male breadwinners who are neither householders nor represented by any natural guardian. Still the grounds upon which their title to vote as electors rest are much inferior to householders who are also natural guardians and representatives of the greater half of the population. The former are units, which represent themselves *alone*; the latter not only represent themselves, but also represent on the average from two to three dependent persons, the support of whom correspondingly increases the amount of taxation which each householder contributes to the support of government. If, therefore, the single adult breadwinner has a legitimate claim to be an elector, the householder's claim is at least three-fold greater.

From what has been observed it is manifest that each electoral district should be represented in Parliament as nearly as practicable in accordance with the number of its population rather than with the numbers of electors, as urged by some. This, however, is a purely theoretical consideration; for in a general way the electors of a given district are nearly in the same proportion to all electors as its population is to the total population. But in exceptional cases, where it is not so, the population base for equitable representation has a much greater claim than the electoral base. There are other considerations why the *population quota* is preferable to the *elector quota* in determining the representative value of any electoral district. Many electors have votes for more than the one district in which the elector and his family resides. Such an one cannot be placed upon equality with the resident elector whose whole interest, including his dependants (non-electors) are bound up in the particular district. The non-resident elector element in the *elector quota*, therefore, destroys its value, and strengthens the grounds upon which representation by *population quota* is sustained. But some may still urge the old fallacious plea, Has property no just claim to representation? So far as the general government of a new country is concerned, the interests of property-holders are quite as varied and conflicting as the population interests *per se*, and the population of a particular district has more interests in common with the property interests within its border than have the property interests of different districts with each other; *e.g.*: The burning question in young colonies is the development of its lands and industries rather than incidence of taxation, and the aid of the General Government in the construction of roads, bridges, harbours, railways, telegraphs, etc., is the rock upon which the interests of property, and people alike, split up into rival interests. The interests of the locality in young colonies are therefore upon the whole the dominating ones ; and in these conflicts the local interests of population and property are in unison so far as local matters are concerned, and together they are in rivalry with similarly combined interests of other localities. Moreover, it must be borne in mind that it is only in matters relating to Municipal Government that property, as such, has a just claim for special consideration in matters relating to representation.

The whole of the advantages secured in urban communities under Municipal Government may include Water Supply, Formation and Repairs to Streets and Footpaths, Sanitation, Protection to Persons and Real and Personal Property, Parks and Recreation Grounds, Street Lighting, etc. The enjoyment of all such benefits may be said to be equally distributed to each member of the community. That is, no matter whether any one person of the community pays little, much, or none of the taxation necessary to provide for most of these common benefits, each individual has the enjoyment of them *equally*. It is therefore reasonable that some extra share of the control and distribution of such common advantages should be placed in the hands of those who individually contribute the greatest share of the taxation necessary to provide for them.

Without such a safeguard it is conceivable that the luxurious demands of a majority who pay little or nothing towards their provision and maintenance might, by an extravagance which does not touch their pockets, almost ruin the minority, who are forced to defray the expenditure.

Having touched upon three distinct considerations which are somehow to be taken into account (Population, Electors, and Property) in the determination of any just and equitable representation of the people, it has been shown that so far as the functions delegated to a General Government are concerned, the best form of representation should be based rather upon the population quota method than upon either the elector or property quota, or upon any combination of these. It is advantageous, however, to show that population *per se* is not only theoretically the fairer method, but from the nature of things it fundamentally determines the number of electors as well as the amount of property. For whatever differences may be shown by individual districts from one another, on the whole, the population quota to the total population will yield for nearly all districts the same representation as the elector quota does relative to the total number of electors, or as the property quota does relative to the total amount of property. Indeed, broadly speaking, the number of the population is not only the fundamental cause or root of the dimensions of the other two categories, but it may be safely taken as a unit measure or index of them. This is significally illustrated by the following contrasts with respect to the principal divisions of Tasmania, taking a common division (40) for determining the respective quotas:—

	Absolute.			Proportion per Quota.					
	Property Capital Value.*	Electors. No. †	Population. No. †	Property.	Electors.	Population.	Mean of Three.	Mean of Electors and Population alone.	Mean Approx. Population.
	£								
North-Eastern Division...	6,603,909	9,792	47,664	11·86	12·71	13·00	12·52	12·85	13
North-Western Division...	3,270,802	6,051	27,213	6·06	7·85	7·41	7·11	7·63	7
Midland Division ...	4,521,300	2,737	13,406	8·37	3·55	3·67	5·19	3·61	4
South-Eastern and South-Western Division ...	7,406,762	12,237	58,384	13·71	15·89	15·92	15·18	15·91	16
Total	21,602,773	30,817	146,667	40	40	40	40	40	40
Quota 1-40th	540,069	779	3,667	1	1	1	1	1	1

* 1890. † Census Year 1891

Practically the proportion per quota of electors and population yield the same result in the detail representation for each sub-division; and the proportion per quota of property is remarkably close upon the whole.

Nay, so far as urban populations are concerned, the proportion per quota yielded by Property, Electors, and Populations invariably shows the very closest correspondence, thus:—

—	ABSOLUTE.			PROPORTION PER QUOTA.			
—	Property Cap. Value.	Electors. No.	Population. No.	Property.	Electors.	Population.	Mean Approximate Population.
Hobart ...	3,134,539	5,237	24,905	5·80	6·80	6·79	7
Launceston	2,768,501	3,746	17,208	5·13	4·86	4·69	5
Both ...	5,903,040	8,983	42,113	10·93	11·66	11·50	12
Quota ...	540,069	779	3,667	1·	1·	1·	1

REPRESENTATION OF LOCALITIES

Having disposed of the question regarding the best method to be adopted for securing a just and equitable representation of the people, there is still a most important end to be secured, viz., a just and equitable representation for distinct localities. For it may readily be conceived that, although each individual of a quota had an equal voice in the selection of the Parliamentary representative, their *locality interests*, by the bad grouping of the boundaries or limits of the electoral district, may be so conflicting as to deprive the electors of power to give effect to them; or, what is the same, their representative would be so hampered by rival suggestions, destructive of each other in regard to locality interests, that he would be powerless to take any action in Parliament in respect of either rival interest.

This is more readily appreciated when we remember that each elector is governed by at least three primary interests, which often conflict with each other in respect to his own individual choice, viz.:—

1. Religious, Moral, and Intellectual Interests and Sympathies.
2. Trade or Calling, or Class Interests and Sympathies.
3. Locality Interests and Sympathies.
4. Personal Sympathies.

It may so happen that during the conflict of one election his mind may be dominated by the first of these, as in the case of the present elections in Ulster, *i.e.*, by religious sympathies. At another time class interests may dominate, as when the question of the day turns upon the relations between Capital and Labour. Again, if the burning question of the day turns upon rival routes for railways, or for the fair claims of the district to a share in the expenditure for the construction of roads or important public works, the locality interests of the individual electors may for the time being become the dominant ones in determining his action or choice. The definition of electoral boundaries, however determined, and so long as they are fairly represented on the basis of population, do not involve serious difficulties to the individual elector in exercising his influence upon the Central Government with respect to his various and variable interests, if we except the interests of locality.

To afford the individual the full force of his electoral privileges in respect of locality, it is necessary that the interests of all electors within any distinct electoral area should be in harmony, *i.e.*, that no important portion of the district should act as a dead weight owing to its locality interests being on geographical or other grounds more identified with some neighbouring electoral district than with its own.

How to secure fair representation on the basis of numbers whilst still preserving intact the solidarity of locality interests is the great problem which the practical politician has to solve; and it is a problem which is surrounded with many more practical difficulties than any of the schemes for representation which are confined to the representation of the person alone. It would not be difficult to divide the country into distinct electoral districts, whose locality interests are fairly identical, solely upon some physical or geographical basis. Nor would it be a difficult matter to cut up the whole country into electoral district units on the basis of population alone.

The practical difficulty only appears when we try to obtain an electoral district unit of representation which will fairly coincide with both of these important considerations.

As a matter of fact, the perfect attainment of such an ideal is utterly impossible. To secure one of its important aims rigidly would in most cases only be attained by the sacrifice of ideal fairness in respect of the other. Fairly perfect units coinciding in both aims would be purely accidental, temporary and exceptional.

Let us examine this matter a little more closely.

Locality interests should mainly be determined by the following circumstances:—

DESIDERATA, OR PRINCIPLES.

1. The interests of the principal industries carried on within the district are not of a conflicting character, *i.e.*, they are mainly Agricultural, Pastoral, Mineral, or Industrial, as the case may be.

2. The main channels of communication by Road or Rail are common to the particular sub-divisions contained therein.

3. The minor or Road Districts included within the district are so far harmonious that they meet in common in the trunk system of the particular Electoral District.

4. The centre or centres for the administration of justice, law, protection, and registration within the district are more convenient to all its sub-divisions than to the corresponding centres of neighbouring Electoral Districts, allowance being made as regards the borderlands, especially of Rural Districts and Urban Districts, where it must ever happen that the inhabitants of a Rural District Boundary *touching* an Urban District Boundary are nearer, or as near, to the Urban centres than to those of their own.

These are the principal conditions which determine the nature of an ideally perfect electoral district based upon locality interests.

The conditions which are demanded by representation on the basis of population are, that every electoral district shall, as nearly as possible, contain one quota of the total population, or in exceptionally populous geographically undivided districts two or more *complete quotas !*

But the density of population of many large distinct geographical areas is so small that it would require to unite as many of them as would cover an area of 3,280 square miles (Franklin) to enable us to satisfy the claims of fairness of representation on the basis of numbers, that is, one quota of the total population; while others (Hobart city) are so dense that 1·98 square miles embraces as many persons as would fairly constitute seven complete quotas. But how are we to reconcile two rival claims for distinct representation, one of which we may call the geographical unit, is rigidly fixed for all time, and the other—the population unit—which varies each day in accordance with the actual changes brought about, naturally by births and deaths, and artificially by constant movements of the population to or from old or new centres of population? Even if we could fix an exact and coincidentally fair representation for all districts at any one moment, such is the variableness of growth or decline ever going on in various districts that it would certainly be out of perfect harmony in both respects within the space of a few weeks.

It is clear, therefore, that the ideal of a perfectly exact and fair representation on the basis of distinct natural geographical units and single population or electoral quotas is practically unattainable, and therefore any objections that may be put forward *on such grounds* to any scheme of representation whatever, will in itself be no conclusive evidence against or for such a scheme, whether good or bad. It will only amount to a truism expressive of the fact *that the impossible has not been achieved.* It is, however, practicable to attain a fair approximation to our ideal in both its important aspects if the two standards of fair and equitable representation be used as tests for measuring the relative value of different plans which most nearly satisfy their claims.

The following are the principles by which a fair and just scheme of Representation may always be preserved, which unites the distinct claims of the solidarity of distinct geographical units with those which rest on the claims of numbers:—

PRINCIPLES.

1. Preserve all Geographical Districts as Single Electoral Districts, whose population does not exceed or fall below the population or Electoral quota by 25 per cent.

2. Unite two or more sparsely populated but distinct Geographical Districts, so that combined they approximate to a full Electoral quota.

3. Where two contiguous Geographical Districts already constitute two single Electoral Districts, only give two Representatives taken separately, but if united would represent three quotas nearly.—Unite the two to form a single Three-member District, with the consent of the Representatives of the original districts in cases where it is impracticable to form a third separate district whose boundaries would not transgress in matters essential to Locality Interests.

4. In fixing the total number of Representatives leave a margin in the aggregate, so that from time to time a single member may be added—in case of a new centre springing rapidly into existence, or an old one suddenly expanding—without any disturbance to other districts, which comparatively may be unaffected in their relation to the Electoral quota—*e.g.*: If the normal number be determined to be 40, fix the standard thus, "not less than 40 and not exceeding 44."

5. In areas that are progressive do not add an additional member for excess of quota until it reaches at least 75 per cent. of the full quota.

6. In declining areas do not cancel the representative of a geographical unit or Electoral District until the deficiency below the quota falls below it by 40 per cent. of the said quota.

7. Where two contiguous Electoral Districts exist, one decreasing in numbers and the other making a corresponding increase, adjustment may be preserved in relation to quota either by amalgamating the two as a single Two-member District, or if not infringing upon the solidarity of Locality Interests of one of them, annex one or more of the complete sub-divisions—say Road Districts—to the smaller population, where it would produce the desired distribution of population.

8. As Local Taxation is levied on the basis of Assessment Rolls relating to Road Trusts and Municipal Districts, and as Population Statistics are obtained in relation to Registration Districts, it is absolutely necessary for determining the Population, Amount of Property, and Trade and Industry of any Division, whether Electoral, Municipal, Registration, or Road Trust, that there should be a systematised plan of harmony between the smaller and the larger divisions.

In urban districts the municipal area should be a multiple exactly of the electoral unit. In rural districts the municipal area should be an exact multiple of complete road district divisions plus its non-road district area regarded as one of the units: and the municipal and electoral district should be so related that the larger of the two should be an exact multiple of the other. The registration district should be identical with one or more multiples of some of the aforesaid divisions. In this way information relating to Population, Trade and Industry and Property obtained by any of the modes now in operation could be readily related to any of the several forms of district groupings. The grand principle of harmony of districts being that the larger division boundary should *coincide exactly* with the corresponding outermost limits of the lesser but complete divisions contained within it. Negatively it may be stated as follows:—

(*a.*) Any Road District should not form parts of two or more Municipal Districts.

(*b.*) Any Municipal District should not form parts of two or more Electoral Districts.

(*c.*) Any Electoral District (Urban Centres perhaps excepted) should not form parts of two or more Municipal Districts.

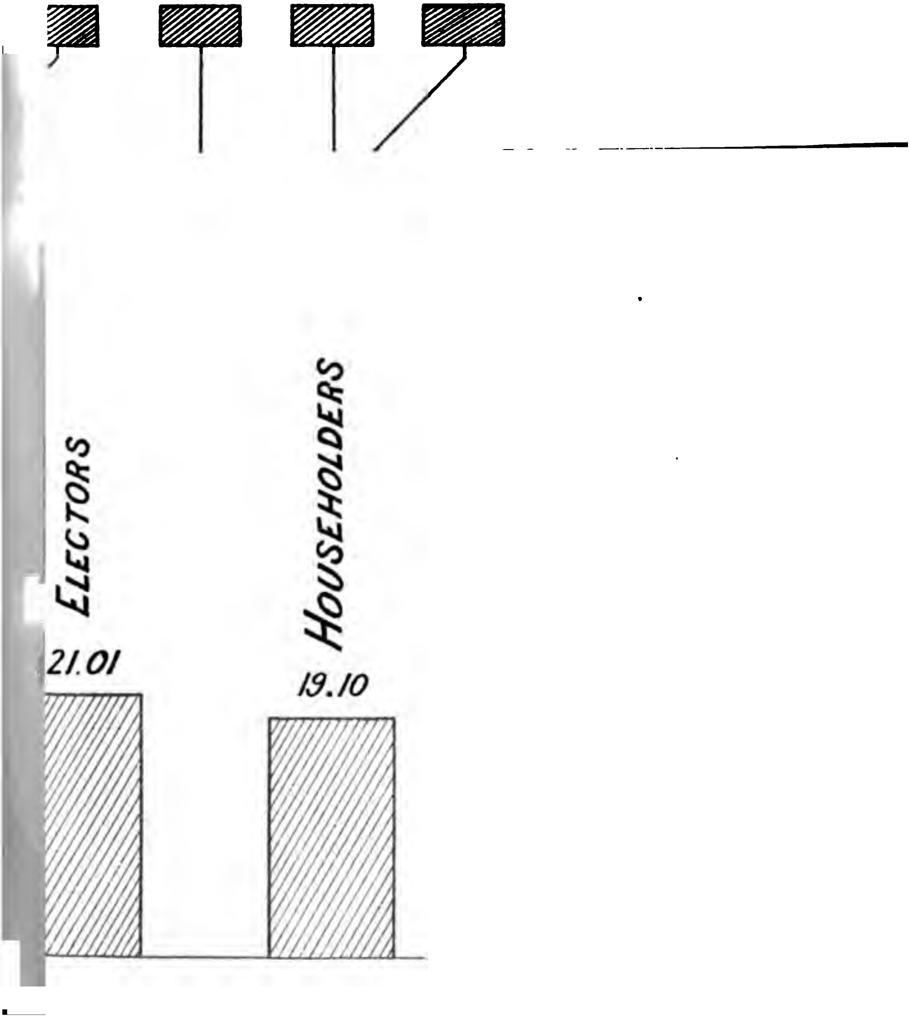
To secure with greatest economy the valuation of property or the state of any industry, the Rolls or Shedules should not be based solely upon the alphabetical order of either streets or names of persons (occupiers), but rather the alphabetical order should be subordinate to one of the smaller systematic sub-division of municipal districts, thus:—

PLAN *of* MUNICIPAL *or* POLICE ASSESSMENT ROLL.

ALPHABETICAL ORDER.	ROAD DISTRICT.	ELECTORAL DISTRICT.	MUNICIPAL DISTRICT.
Names.			SUMMARY. Electoral District *x*. Road District A... „ „ B... „ „ C... Total Electoral District *x* ... ... Electoral District *y*. Road District D ... „ „ E ... „ „ F ... Total Electoral District *y* ... ... Grand Total Municipal District ...
a			
b	A		
c			
Total.........			
Names.			
a			
b	B	*x*	
c			
Total			
Names.			
a			
b	C		
c			
Total.........	Total		
Names.			
a			
b	D		
c			
Total..			
Names.			
a			
b	E	*y*	
c			
Total.........			
Names.			
a			
b	F		
c			
Total.........			

If a scheme of representation satisfies all these conditions, it is the best scheme which is practically attainable, and is not defective from this point of view, even when it may show in many instances a considerable departure from the ideal standard of perfection.

PEOPLE. —



REMARKS ON SIR ROBERT BALL'S PAPER (READ AT THE HOBART MEETING OF THE AUSTRALASIAN SCIENCE ASSOCIATION), ENTITLED: "THE ASTRONOMICAL EXPLANATION OF A GLACIAL PERIOD."

BY A. B. BIGGS.

Of the many interesting papers that were read in the Astronomical Section of the recent Science Congress, by far the most interesting to me, and probably to the majority of those who listened to it, was that with which we were favoured by Sir Robert Ball, and which was read by His Excellency, Sir Robert Hamilton.

In the paper referred to, Sir John Herschel is accused by the author of having made, in his "Outlines of Astronomy," "a curiously erroneous statement:" that "Herschel wrote down hastily a statement which was quite wrong," and that Croll and others had been misled by Herschel's mistake.

It was startling to me to find two men of such eminence in Astronomical Science at variance with reference to a comparatively simple astronomical fact. Sir Robert Ball announces, as the object of his paper, "to indicate clearly the character of the error . . . and to substitute for it the correct mathematical theory." So that he is very emphatic upon the subject of the supposed mistake.

I did not feel myself in a position to criticise the paper at its reading, even had I the temerity to attempt it. I needed to study it at leisure before venturing on so bold a step. The receipt of a copy from the General Secretary of the association has put me in a position to look into the matter more closely.

The purport of Sir Robert Ball's paper is to show that the successive periods of glaciation, alternating with periods of genial or tropical temperature, which geologists infer from the indications of the rocks and strata, are a necessary corollary from astronomical data. It will be well then, as a preliminary, to state as concisely and clearly as I possibly can what are the conditions of the problem, which I take to be the following, every one of which is essential to the conclusion arrived at:—

1. That the earth's orbit is not a circle, but an ellipse, the sun's position in relation thereto being, not in the centre, but in one of the foci of the curve; consequently there are two opposite points at which respectively the earth is nearest to,

and farthest from the sun (Perihelion and Aphelion), these points being reached at the beginning of January and the beginning of July.

2. That a bisection of the orbit by a line through the sun's centre in any direction but that of coincidence with the major axis of the ellipse will cut the orbit into two unequal divisions, of which that which comprises the perihelion will receive the greater intensity of heat, in accordance with the law of inverse squares of distance.

3. Nevertheless, as the earth's angular velocity is in the same ratio of inverse squares of distance, the *total amount* of heat received in the one division of the orbit (and of the year), will exactly equal that received in the other division. Further, the year's supply will be equal in the two hemispheres.

4. That owing to the disturbing attraction of the planets (Venus and Jupiter principally), a slow variation is produced in the length of the minor axis of the earth's orbit, the major axis remaining constant. This amounts to saying that the eccentricity varies. This variation oscillates within certain limits, and occupies an enormously long period.

5. As a further effect from planetary perturbation, the direction of the major axis undergoes a slow progressive change, making a complete revolution in about 110,000 years.

6. That the moon's attractive force upon the earth's equatorial protuberance causes a gyration of the polar axis in a circle of 47 degrees in diameter, and the consequent revolution of the line of the equinoxes in the comparatively short period of 25,000 years.

7. The movement described above (6), known as the "precession of the equinoxes," and the revolution of the major axis of the orbit (5) being in opposite directions, it follows that they will recur to the same relative positions in the shorter period of 21,000 years.

8. The elementary fact of the inclination of the polar axis to the plane of the orbit at an angle of 66½ degrees must be takent into account. Upon this, and this only, depends the relative distribution of the total yearly supply of heat between the summer and winter seasons of the year in either hemisphere. This is shown by mathematical formulæ to be in the ratio of 63 to 37 nearly, *which ratio remains constant under all circumstances.*

There is still one other condition, as laid down by Sir Robert Ball, equally essential, but which I will postpone for the present, and will proceed to discuss the bearing which the foregoing postulates have upon the problem.

It must be evident that, at enormously long intervals (as we judge of time), the combined effects of the conditions above enumerated must be at a maximum as regards the relative *intensity* (as distinguished from *total amount*) of summer and winter heat. This will be when the eccentricity of the orbit is at its maximum, and the relative movements indicated in Nos. 6 and 7 have brought the line of the equinoxes at *right angles* with the major axis, thus cutting the orbit into its shortest possible perihelion, and longest aphelion divisions. That hemisphere, then, which has the perihelion summer will have its summer portion of heat (see No. 3) concentrated into a short and intensely hot summer; whilst its winter portion will be spread over a long, cold winter. At the same time the reverse of this will prevail in the other hemisphere. These conditions will alternate between the two hemispheres in the mid interval of 10,500 years.

I must now add, as No. 9, a further condition as laid down by Sir Robert Ball, which is, that "the sunbeams in the brief and fiercely hot summer of the glacial period *fail to melt as much ice as had been accumulated during the preceding winter.*" If this statement is correct, it must be admitted, I think, that the theory is established beyond question. If, on the other hand, it be not correct, and that the intensity of summer heat compensates the prolonged coldness of the winter (and this is the only point that is not quite clear to my mind), the theory breaks down utterly, even though all the other conditions remain intact.

The point on which Sir John Herschel is challenged by Sir Robert Ball is contained in the concluding sentence of condition 8. Sir Robert Ball puts the case as against Herschel thus (I cannot well shorten the quotation):—

"Suppose that the total heat received from the sun on one hemisphere of the earth during the course of a twelvemonth be represented by 100, we proceed to consider how these parts are shared between the seasons. I mean by 'summer' in the Northern Hemisphere the interval from the vernal equinox to the autumnal, and by 'winter' the interval from the autumnal equinox to the vernal. With this understanding 63 parts of heat are received on each hemisphere during its summer, and the remaining 37 parts during the winter. . . . Herschel's erroneous statement was to the effect that *the heat was equally distributed, so that* 50 *parts were received in summer and* 50 *parts in winter.*" (All italics are mine unless otherwise indicated.)

Now, the question is:—Is this just what Sir John Herschel said or meant to say? The passage on which Sir Robert Ball founds his charge can be only that on page 333 of the

5th edition of Herschel's "Outlines of Astronomy," which runs thus:—

"Supposing the eccentricity of the earth's orbit were very much greater than it actually is, the position of its perihelion remaining the same, it is evident that the character of the seasons in the two hemispheres would be strongly contrasted. In the Northern we should have a short but very mild winter, with a long but very cool summer,—that is, an approach to perpetual spring; while the Southern Hemisphere would be inconvenienced and might be rendered uninhabitable by the fierce extremes caused by concentrating half *the* annual supply of heat into a summer of very short duration, and spreading the other half over a long and dreary winter, sharpened into an intolerable intensity of frost when at its climax by the much greater remoteness of the sun." (Mark, "*the* annual supply," not *its*, etc.)

It must be admitted that, on a cursory reading, and taking it apart from its context, the above passage would appear to bear only the construction which Sir Robert Ball puts upon it. But is it fair, so to take it, or to take any man's utterances? Herschel has just been taking great pains to make clear the fact that (dividing the year and the orbit each into its—at present—two unequal portions by the equinoctial diameter of the orbit), though the earth is nearer the sun during the (northern) winter portion of the year than during the summer portion, and is consequently receiving a greater intensity of heat (according to the law of inverse squares of the distance), the earth's angular velocity being in the same ratio, the shortness of the season exactly compensates the intensity of radiation. He sums up the case thus:—

"The momentary supply of heat received by *the earth* in every point of its orbit varies exactly as the momentary increase of its longitude, from which it obviously follows that equal amounts of heat are received from the sun in whatever part of the ellipse those angles are situated. Supposing the orbit, then, to be divided into two segments by any straight line drawn through the sun, since equal angles in longitude (180 deg.) are described on either side of this line, the amount of heat received will be equal. In passing, then, from either equinox to the other, the *whole earth* receives equal amount of heat," etc.

Now take this quotation in connection with that to which Sir Robert Ball takes exception, as quoted above, and I think Herschel's meaning will be apparent, although in this case it must be admitted that he has failed to express himself with his accustomed preciseness. His statement is that "the hemisphere would be inconvenienced . . by concentrating half *the*" (not *its*) "annual supply of heat into a summer of short duration," etc., which is of course apportioned between the summer of one hemisphere and winter of the other alternately, and he can only be referring to that portion of this "supply" which pertains to the summer or winter of either hemisphere. That he could have meant nothing else is still more evident from a further quotation (page 230), in which he admits the unequal distribution of heat between summer and winter:—"Whenever, then, the sun remains more than 12 hours above the horizon of any place, and less beneath, the general temperature of that place will be above the average; when the reverse, below;" that is, the summer and winter portions of the year respectively.

The extent of the inequality of the distribution of the annual supply of heat between the summer and winter portions of the year in either hemisphere depends (as I have said) wholly and solely upon the inclination of the earth's axis, and no one could be more cognisant of this fact than Sir John Herschel. Assuming extreme conditions, the inclination of the axis, instead of being some 66½ deg., might have been zero, that is, coincident with the plane of the ecliptic, in which case the distribution of summer and winter heat (the yearly total), in either hemisphere (employing Sir Robert Ball's formula), would be as 818 to 182. On the other hand, the inclination might have been 90 deg., that is vertical, when there would have been no inequality, and the distinction of summer and winter would vanish. The inclination being actually between these two extremes (that is, 66½ deg.), the relative summer and winter heat supplies must lie between the aforesaid ratios, and is no doubt correctly stated by Sir Robert Ball as 63 to 37.

Of the geological aspect of the question I do not deem myself competent to speak; but, admitting the deductions of geologists as to the alternations of extreme heat and cold in the geological history of the earth, and the correctness of Sir Robert Ball's dictum with regard to the inefficiency of the extreme summer hear to dissipate the glacial effects of the preceding winter's cold (No. 9), the theory discussed by Sir Robert Ball is, I think, the only one yet propounded that will bear investigation.

ON THE PROPOSED LEAKE SCHOOL OF PRACTICAL ASTRONOMY.

BY H. C. RUSSELL, F.R.S., C.M.G., GOVERNMENT ASTRONOMER OF NEW SOUTH WALES,

Corresponding Member, Royal Society of Tasmania.

During my visit to Hobart in January last I was struck with the brightness and translucency of the atmosphere, and it was evident to me that the weather of the fortnight I was in Hobart would have enabled me to do as much as I had done in Sydney during the preceding two months. And, in conversation with some friends, I expressed regret that such fine skies for the Astronomer should not be taken advantage of, and an Astronomical Photographic Observatory established. I was told that Tasmania, like other parts of the world, was passing through a period of commercial depression, and the Government did not seem to be disposed to add to expenditure by starting an Observatory, but that the late Mr. Leake had left a sum of £10,000 for the foundation of a School of Astronomy, and it was hoped that an Observatory would be established very soon.

And it seems to me most fitting that the colony in which this noble bequest was made should be the first to take it up and benefit by its provisions; and the establishment of a Tasmanian University will, with the co-operation of the Senate, enable the trustees to carry out in a most satisfactory manner the wishes of the testator, who indeed seems to have contemplated such a natural combination as that now proposed between his trustees and the Senate of the University for the establishment of a School of Astronomy.

Such an addition as this to the functions of the University would be an immense advantage. In the first place, it will add to the curriculum another subject which students may take up, either as technical education or as a most valuable mental training in a general course of study. Next, it will induce some students to come to the University in order to attend the lectures on Astronomy, and if provision is made for non-matriculated students to attend the teaching in practical Astronomy on payment of fees, there can be no doubt that many will enrol their names.

The desire to contribute in some way towards the consummation of the proposed Observatory scheme, which seems to me so desirable, and so easy of attainment with the means at command, has induced me to make the following suggestions;

but before going on to these, I may point out that Hobart, in addition to its clear atmosphere, possesses in its high southern latitude a great advantage over any other available place for the new Observatory in the Southern Hemisphere. It is true that a slightly higher latitude is available in New Zealand, but the climate is less favourable, and the means to build an Observatory are apparently not forthcoming, and if one were erected in New Zealand it would no doubt be at Wellington. So that, practically, Hobart not only possesses the means, but also the best available site in the Southern Hemisphere for the Leake Observatory.

The extreme south part of the Milky Way is for the Astronomer an almost unexplored mine of wealth, and he will be in the best position to acquire the gems which it contains who has the greatest southern latitude for his instruments, because these parts of the heavens will come nearest to his zenith, and therefore suffer least by the Astronomer's greatest enemy, the impurity of the atmosphere. Admitting, then, the advantage of position, about which there can be no doubt, it may be pointed out that the time is opportune, and to establish the Observatory now would be gratifying to Astronomers generally, because the complete scheme for carrying out the work arranged by the Astronomical Conference in Paris, in 1887, according to which 18 Observatories agreed to divide the work of making a photographic chart of the whole heavens, has been to some extent marred by the political troubles in South America, owing to which three Observatories there have been unable to take up their part of the work. And the question is pressing upon the general committee in Paris,—How shall that portion of the photographic work which South America undertook be provided for? Under these circumstances the establishment of an Observatory to take up even a part of the work, would, by that fact alone, be brought into immediate prominence and earn the good wishes of all Astronomers.

But, in addition to the honour which would come in this way to Tasmania, if the work is undertaken by the University in co-operation with the Leake trustees, as I understand is proposed, the University of Tasmania will be the only one in Australasia having a complete School of Astronomy; that is, one in which the theory and *practice* of the science are taught, and it is natural to expect that students who want to take up the study, either as a mental culture, or with the object of making use of it practically in surveying or in a private Observatory, will naturally go to the most complete school. And if the teaching in such a school is thrown open to the public, so that on payment of fees non-matriculated students can attend, I am sure that a number of persons will be found ready to take advantage of it, and thus get initiated into the study of the grand science which entices so many to the private study of it. But the teaching must include the use of instruments as well as lectures upon the theory and practice. Indeed, an Observatory is just as essential to the teaching of Astronomy as the dissecting room is to surgery, the laboratory to physics, or the workshop to engineering.

In the present day Astronomy covers such a wide range of subjects, and requires the use of so many expensive instruments, that no Observatory, even the great National Observatories of Europe, attempts to take up all of them, and it is usual for Observatories to take up some *special subject*, and in this way the whole study is carried on by a number of independent Observatories. I think, therefore, the idea of having an Observatory covering all branches of Astronomy in Tasmania may be dismissed, and our attention confined to the requirements of one which will fulfil the testator's intention, and at the same time take up *one special branch* of the subject, and place Tasmania at once amongst those countries in which the Observatories are taking an effective part in promoting the progress of Astronomy; and, without doubt, the best way is to make its special feature *astronomical photography*. Such an Observatory, as I have already pointed out, is badly wanted in the Southern Hemisphere, and Hobart has special advantages of climate and position for the work.

We may then, I think, begin with these conditions, viz., that the Tasmanian Observatory should provide:—

(1.) All that is necessary for practical teaching in the School of Astronomy established within the University under the Leake bequest.

(2.) That its special work shall be Astronomical Photography.

(3.) That its name shall be the "Leake Observatory."

(4.) That its control and management shall vest in the Council of the University.

(*a*.) I have assumed that the Leake trustees are prepared to hand over to the University the Leake bequest of £10,000 for the establishment of a school for the practical teaching of Astronomy, provided that the Senate make such provision for it as will carry out the testator's wish as laid down in his will.

(*b*.) I have also assumed that the Government or the Senate of the University would provide a *site*, a piece of ground about 60 feet square, for the Observatory to stand upon.

(*c*.) Further, that the Government would keep public time as they do at present, and give time to the Leake Observatory, and permit the Leake Lecturer in Astronomy to use their transit instrument from time to time for teaching students in Astronomy.

If the arrangement assumed in (*c*) could not be made, there would still be sufficient funds out of the £3,000 *for instruments* for the purchase of a transit instrument. (See appendix A.)

The necessary equipment for an Observatory consists of a transit instrument, an equatorial with attached star camera, a good clock, photographic outfit, furniture, etc.

If it were proposed to devote the Observatory to the making of star catalogues, the greater part of the money would have to be spent upon the transit instrument; but since this is not proposed, a transit instrument of moderate cost will serve every purpose, and the greater part of the expenditure may properly be made upon a really fine equatorial with star camera attached,—such an instrument, in fact, as is used by all the 15 observatories taking part in the great work of photographing the heavens. This is, in the first place, an equatorial telescope of 10 inches aperture, and mounted on a stand of the most perfect kind that modern instrument makers can make, and so constructed that it carries with the telescope a star camera, with an object glass of 13 inches diameter. Such an instrument would be fit for any extra meridian work in addition to its use with the star camera. In fact, this instrument would be an exact counterpart of the instruments used in Greenwich, Paris, and other first-class Observatories for similar work, and would place the "Leake" Observatory in a position to do *first class work*, with the advantage of position over all other southern Observatories.

The only building required would be a round one, 26 feet in diameter, with revolving roof, and having cellar space sufficient for photographic work.

One first class regulator clock, together with some photographic and electrical apparatus and furniture, would complete the outfit, the cost of which I have estimated in appendix A.

I have been careful to add to the actual cost of the smaller items from 25 to 40 per cent. in each case, well knowing that contingencies arise which increase the cost.

The great item, the equatorial, I have set down at the price paid by Greenwich, the Cape, and Melbourne. In providing for the staff of the Observatory, I have ventured to suggest the appointment of a Demonstrator in Physics, in addition to the Lecturer, or rather to help the Lecturer in Mathematics, Physics, and Astronomy, because experience here shows that the professor or teacher in these subjects must have some help of the sort. If the expenditure is deemed too great, it could be reduced to, say, £100; for which salary I have no doubt an educated youth, or perhaps one of the students, would undertake the duty. The sum proposed, £250, would find an able Demonstrator, whose services in teaching science would materially add to the success of the school. If, however, it be decided not to have him at all, it would be better to increase the salary of the Photographer to £200, and get a man with wider experience, who should then be called *Observatory Assistant*. It will be observed that such a change, *i.e.*, omitting the Demonstrator and increasing the salary for the Observatory Assistant, will not alter the charges for salaries.

The sum of £50 a year set down for photographic plates, chemicals, etc., would, I have no doubt, cover the incidental expenses.

It would be a legitimate although perhaps small increase to the Observatory funds to hand over to it for current expenditure the fees paid by non-matriculated students of Astronomy.

It would be an easy matter to suggest various other instruments for the Observatory.

To Recapitulate.

It is proposed that the Leake bequest of £10,000 be handed over to the University.

That the University establish a School of Astronomy and an Observatory, to be called the Leake Observatory.

That the Lecturer in Mathematics and Physics should also teach Astronomy, and have, under the governing body of the University, general control and direction of the Observatory, for which he should be paid from the Leake fund £100 per annum in addition to his salary from the University.

That an Observatory Assistant be appointed with salary of £200 per annum from the Leake fund.

That, if possible, the University should obtain permission from the Government to use their transit instrument for teaching purposes. If not, that a transit instrument be purchased at a cost of £110.

That a site for the Observatory be provided by the Government or the University.

That one round Observatory with revolving roof be built.

That a large equatorial, with star camera attached, be purchased at a cost not exceeding £1,800, together with necessary apparatus. (See page 4 and appendix A.)

That the Observatory work should be Photographic Astronomy, in connection with the photographic star chart now being made.

APPENDIX A.

SALARY.

Office.	University.	Leake Bequest	Total.	Remarks.
A Lecturer in Mathematics, Physics, and Astronomy.	£500	£100	£600	To give fifty lectures on Astronomy each year, and have general oversight and direction of the Observatory.
B Demonstrator in Physics and Astronomy.	*£200	£50	£250	To demonstrate in Physics and Astronomy and have general charge of the instruments.
C Photographer ...	*—	£150	£150	To do all photographic work and any other that may be necessary.
D Photographic Plates and Chemicals ...	—	£50	—	—

COST OF INSTRUMENTS, ETC.

		£	s.	d.
E	Equatorial telescope and star camera combined	1,800	0	0
F	Freight and charges	100	0	0
G	Observatory building	200	0	0
H	Clock	50	0	0
I	Batteries, furniture, etc.	50	0	0
J	To cover unforeseen expenses	200	0	0
	Total cost	£2,400	0	0
K	Reserve fund	600	0	0
E to K	Leake bequest for instruments	£3,000	0	0

Annual expenditure under A B C & D, amounting to £350, the interest on £7,000 from Leake Estate; in reference to B see page 30.

TRADE UNIONISM AS A FACTOR IN SOCIAL EVOLUTION.

By Alfred J. Taylor, F.L.S., F.R.G.S., E.

In any endeavour to trace the evolution of social life, we may safely assume as a starting point that the family is the natural foundation of all social relations.

Blood relationship would naturally, in its infancy, form the strongest tie between members of the human race. Then would come the ties of kinship: and these in turn would broaden out into the realisation of duties as between man and man—the observance of which would be necessary to give stability to a brotherhood based on the foundations of a *general* social relationship. As the conditions of society became more complex, various and conflicting interests would necessarily arise; and in time would become developed those well-defined separations of interests that characterise the social relations of the Nineteenth-Century Civilisation.

It is with one of these well-defined lines of development in social life that I have now to deal: and as all social and political changes are of slow growth, it must be remembered that I cannot possibly do more than touch upon some of the salient points in a subject so vast and interesting as that which we are about to discuss:—Trade Unionism as a Factor in Social Evolution.

In the first place I would remind my hearers, that as one of the necessary factors in the development of a higher civilisation a time was reached in the history of the human race when it became necessary for those having special regard for particular interests to combine for the promotion and protection of those interests.

Combination became necessary, for example, to counteract influences that were likely to become dominant to the injury of the common good: and thus we find that in the middle ages combinations known as "Craft Guilds" were formed in which masters and workmen united to protect the interests of certain trades.

These Craft Guilds, after long and obstinate struggles, succeeded in winning certain privileges and political powers that paved the way for the succeeding victories that have been won by the modern combinations known as Trade Unions.

The Craft Guilds, however, differed from the Trade Union in so far that, while under the former, masters and men combined for the common object of protecting their particular trades; the Union is designed to regulate the interests of Trade "exclusively from the workman's point of view. Instead of the Guild in which masters and men were as one, we have on the one hand the association of the employers, and on the other the unions of the workmen." (*Subjects of the Day*, page 106, August, 1890.)

At the time of the ancient Guild comparative equality prevailed. The master trained, personally, his own apprentices, who were in most cases inmates of his dwelling. The relationship between master and man was almost that of the family, "and their trade was a mystery not to be communicated to outsiders." But as the conditions of society changed, the masters, being the strongest, used their power "rather to advance their own individual interests than to serve the good of the whole trade," and this was the disintegrating factor that ultimately led to the breaking up of the Craft Guilds, and left labour without organisation of any kind whatever.

Taking advantage of their helpless condition, the dominant class, for the time being, influenced the Legislature to pass laws for the special government of the workers, to which we can only now look back with wonder and amazement.

Under the laws referred to, labour was enforced as a duty, and refusal to work was punished as a crime. "The rates of wages for which men should work were fixed by act of Parliament; and it was equally an offence for the workman to demand, or the employer to pay, more than the law specified. Combination of every kind was strictly prohibited, and any found uniting for the purpose of dealing with the conditions of labour were subjected to extremely severe penalties." (Ibid., page 107.)

Under Act 2 and 3, Edward VI., c. 15 (which is regarded as the starting point of Legislation against combinations), it was enacted "that if any artificers, labourers, etc., should conspire, covenant, or promise that they should not make nor do their work but at a certain rate, or should not work but at certain hours, they should forfeit, for the first offence, £10, or suffer wenty days imprisonment; for the second offence £20, or the pillory; for the third offence £40 or the pillory, and the loss of one ear," etc.

This law, we are told by the writer I have already quoted, "was in spirit but a type of all the Legislation affecting labour which prevailed right down to the end of the first quarter of the present century." "Indeed," he observes, "it is not too much to say, as Professor Rogers has done in his book on wages, that from the times of the Wars of the Roses up to the repeal of the combination laws, all legislation was 'a conspiracy concocted and carried out by parties interested in its success, entered into to cheat the English workman of his wages, to tie him to the soil, to deprive him of freedom, and to degrade him to irreparable poverty.' "

We all know the natural fruits of such legislation. Refused the privilege of stating their grievances openly and the right to combine to enforce, even in a legitimate manner, a recognition of their wrongs, men will work in secret and endeavour to accomplish by stealth, and in an illegal manner, the ends that should be attained constitutionally, if the truest interests of society are to be conserved.

It was so in the instance under consideration. When the workers found that they could do nothing lawfully to better their condition and relieve them from their enforced slavery, they formed secret combinations; for, as Howell has rightly affirmed, "Tyranny and oppression will always produce men who will not be deterred, by any consideration of danger, from combining to resist what they deem an injustice."

After the passing of the prohibitory laws I have referred to only the most zealous workers combined openly, "but," says Howell, "under the cloak of friendly societies many associations were formed . . . Secrecy was the child of suppression; the Legislature forged at once the chains of the workmen and the weapons for their deliverance."

When the law prohibited combination on the part of the workers, the journeymen tried to fix a list of prices. This the employers opposed on the ground that they alone had the right to fix the price of labour. The idea of arbitration in such matters was also opposed.

That the efforts of the workmen to combine were to some extent successful is sufficiently shown in the fact that at the commencement of the present century strikes were found to be common in almost every trade. Class interest and influence was consequently once more brought to bear, and in the year 1800 a statute was passed directed against all associations of workmen established for any of the purposes for which such societies where then in existence; for, as I have just mentioned, under the pretext of being friendly societies, associations had been formed having for their object the furthering of the interests of the workers as against the influence and power of the masters.

By the statute referred to (40 Geo. III., c. 106) all agreements between journeymen and workmen for obtaining an advance of wages for themselves or others, or for reducing the hours of work, or preventing the employment of hands, or in any way affecting any person carrying on any manufacture, was declared to be illegal. Power was given to one Justice of the Peace to convict summarily and impose imprisonment for two months upon any workmen making such agreements, or interfering in the other ways mentioned.

Under this law those who were bold enough to defy its provisions were made to suffer heavily; for the laws were put in force without mercy, and oftentimes in defiance of justice. As an instance, it may be mentioned in 1805 three linen-weavers were sent to Wakefield gaol for three months—one for the offence of carrying a letter to York requesting assistance from other workmen. The men were invariably punished very severely, but they invariably failed whenever they attempted in turn to prosecute the masters for combination, athough some of their cases were fully proved. I might cover pages in quoting instances in support of these statments, but that would only unnecessarily trespass upon the time I have at my disposal. Those who are curious in the matter I must refer to Howell's excellent account of the Conflicts of Capital and Labour, pp. 105-7.

"The history of these persecutions and contentions," says that writer, "and the consequent privations endured by the workmen, for the purpose of securing their independence, is a real record of heroism. In spite of oppression the most crushing; of legal enactments the most stringent; of punishments the most cruel for any infraction of these acts, the men continued to combine; they contested every inch of the ground, until, after a struggle of centuries, they were on the threshold of victory; partial, it is true, but still most important, viewed by the light of later facts. . . . . A few men in Parliament, with Joseph Hume at their head, had observed their struggles for industrial freedom, and in the year 1824 they moved for and obtained the appointment of a Select Committee of the House of Commons to consider the laws relating to workmen and artisans." The conditions under which the workers were struggling at this time may be judged from the statement of the same historian that "there are men still living who can recollect the time when they had to bury the books and records of their Society on the Town Moor of Bolton, in Lancashire, when oaths had to be resorted to, and were administered to for the purpose of securing mutual protection; when to ask for a rise of wages, or even to receive an advance, if offered, was a violation of the law," and when the exportation of machinery and the emigration of artisans was alike forbidden.

In due time Mr. Hume's committee brought up its report. Briefly summarised, it admitted that combinations of workmen had taken place in England, Ireland, and Scotland, and that at the time of taking evidence such combinations were in existence, attended with strikes—the object being to keep up wages, regulate the hours of working, and to impose restrictions upon the masters respecting apprentices or others whom they might think proper to employ; that serious breaches of the peace had resulted, attended with loss both to masters and workmen, and that the laws relating to combinations had not only not been efficient to prevent combinations, either of masters or of workmen, but on the contrary, in the opinion of many, had a tendency to produce mutual irritation and distrust.

The Committee expressed the opinion of its members that masters and workmen should be freed from the existing restrictions regarding rates of wages and hours of working, and be left at perfect liberty to make such arrangements as they might naturally think proper; also, that the Statute Laws interfering in these particulars should be repealed, as well as the common law under which a peaceable meeting of masters or workmen could be prosecuted as a conspiracy.

While suggesting these concessions, the committee recommended "That it is absolutely necessary, when repealing the Combination Laws, to enact such a law as may efficiently and by summary process punish either masters or workmen who by threat, intimidation, or acts of violence, should interfere with the perfect freedom which ought to be allowed to each party of employing his labour or capital in the manner he may deem most advantageous." (Howell.)

The result of the Select Committee's Report was the Act of 1824 (5 Geo. IV., c. 95).

This Act relieved workmen from all liability to punishment for engaging in peaceful combinations or strikes.

Strikes on a large scale immediately occurred in various parts of the country, and the Legislature was seized with a panic, which the manufacturers did their best to promote. Towards the end of the session the panic subsided, and "all parties," we are told, were contented with a reproduction of the Act last quoted "with some alteration in its shape, and in the language of some of its provisions." Statute 6 Geo. IV., c. 129, therefore took the place of Statute 5 Geo. IV., c. 95.

The employers realising that their former power to crush the workers and force them to accept the terms they might dictate was gone, were far from being satisfied; and in 1830 they succeeded in obtaining another enquiry bearing upon combinations and strikes. The report was fruitless, and was never officially published, but from the portions of it published in 1862 by Mr. Senior—and afterwards in his "Historical and Philosophical Essays" (1865)—it has been shown that it was adverse to the workmen.

Under Statute 6 Geo. IV., c. 129, while exempting from punishment persons meeting together to determine wages and hours of labour (which the persons actually present at the meeting might require or agree to give), the law defined all combinations or agreements affecting the wages or hours of work of persons *not present* at the meetings as conspiracies. Under the definition of conspiracies were also included attempts to control a master in the management of his business, and agreements not to work in company of any given person, or to persuade others to leave their employment, or not to engage themselves. For such offences the law-breakers were liable to fine and imprisonment.

At this period the growing activity of the Unions, and the frequent recurrence of strikes, intensified the anxiety and enmity of the employers.

In 1834 an incident occurred that brought into prominence the disabilities under which the workers were still labouring.

"Six Dorchester labourers," says Howell (p. 116), "were convicted and sentenced to seven years' transportation, ostensibly for administering unlawful oaths, but really for the 'crime of combination.' This conviction was so manifestly unjust, and the sentence so outrageously cruel," he continues, "that some of the ablest, certainly the most independent, men of that day condemned *both*, in no measured terms; and they resolutely demanded the remission of the sentence on these six poor men, and their immediate liberation. An immense demonstration took place in the Copenhagen Fields, on Monday, March 21st, 1834, attended, it is said, by about 400,000 persons; and a procession between six and seven miles in length, consisting of nearly 50,000 workmen, proceeded to the official residence of Lord Melbourne for the purpose of presenting a petition with over 266,000 signatures, on behalf of those six convicted peasants. After a good deal of opposition on the part of the Whig Ministry of that day, backed as it was by the major portion of the manufacturing classes, and, after much delay, the men were 'pardoned,' and ordered to be liberated. But the whole proceeding in regard thereto," the writer goes on to say, "were shamefully cruel and even cowardly. The men had been hastened out of the country" (to New South Wales), "and, even when they were pardoned, some of them did not hear of their pardon until years afterwards, and these might never have heard of it until the expiration of their sentence, had it not been for the merest accident of one of them falling across an English newspaper in the colony."

This case, as might be expected, gave an impetus to the cause of Unionism. Stimulated by the successful meetings they had been able to organise, the workers were led to make an effort to establish a national federation of the whole of the trades. A weekly newspaper was started to assist the scheme, which for a time gave promise of success. When, however, the men who had been convicted were pardoned, the agitation cooled down. But the workers had got to realise their power. "Permanent work," says Howell, "had already begun to take the place of mere spasmodic effort; the several trades were busily employed in perfecting the machinery of their organisation, and thenceforth it is not difficult to trace their systematic operations, and discover the permeating influence of their associative strength and power."

The history of Unionism from this stage for some years afterwards is a record of strikes, prosecutions, and protests, not against the law, but against the way in which it was being administered.

The prosecutions and convictions resulted in the Unions increasing in number; and, on March 25, 1845, a Society was established, under the title of the National Association of United Trades, which became the the centre of a great movement, and gave birth to a newspaper called the *Labour League*. It proposed to raise a sum of £50,000 to provide a fund for the support of workers thrown out of work by labour disputes. It bore fruit in the consolidation of trade associations, and the better understanding of the aims and objects of the Unions.

In 1856 a Select Committee was appointed to enquire into matters connected with masters and operatives; and in 1860 another committee was appointed for a similar object. These inquiries served the purpose of throwing light upon the questions at issue betweeen the employers and the workmen.

As I have already mentioned the feeling of the workmen had not been so much against the law as against its administration, but the Builders' Strike and lock-out in London in the year 1859—the excitement attending which created universal interest for many months—brought about a crisis that led to an organised effort and demand for the amendment of the law itself. The Press took the side of the employers, and denouncing the Unions as Secret Societies, "whose power was sustained only by terrorism," demanded that they should be stamped out as an incurable and detestable evil. The Unionists replied by challenging investigation. In the year 1866 it was shown as the result of enquiry by a Select Committee, that the average number of convictions, under the existing laws in England and Scotland alone exceeded 11,000 cases annually. The enquiry led to the passing of the Master and Servants' Act, 1867.

In the latter year outrages said to have been committed in Sheffield, Nottingham, and Manchester, led to the appointment of a Royal Commission, with power to enquire into the organisation, rules, operations, and conduct of trade societies.

"The investigation," Howell tells us, "was searching and complete. The result was embodied in 16 volumes of reports; the ordeal was a severe one, but," he adds, "the Unions as a whole came out of it *without a stain*."

Trade Unionism, and the cause it represented, had won a great and glorious victory. This was demonstrated in the results of the enquiry. Instead of Legislation to suppress "the incurable and detestable evil," a Temporary Act, protecting the funds of the Unions, was passed in the year 1869, and two years afterwards was passed a Trade Union Act, which sanctioned their objects and legalised their action.

What a shout of victory must have gone up when the workers realised that the law might be appealed to in the future for their protection, and might no longer be used as an instrument of persecution and revenge in the hands of their masters!

And it was in their onward march from this point that we have had a splendid illustration of the truth of Mr. Gladstone's utterance when he declared that we may always trust the People.

"After the passing of the Criminal Law Amendment Act, 1871," writes Howell (p. 126)—and let the record ever remain to the honour and glory of the Trade Unions—"the agitation for the total repeal of all the penal laws affecting labour became more and more intensified and persistent;" but "the action for securing this end was constitutional and methodical; the public mind was educated by meetings, lectures, publications, annual congresses, deputations to ministers, and interviews with members of Parliament, and by debates, bills, and petitions, until at last a Conservative Government in 1875, after a slight show of resistance, with the excuse and help afforded by the report of another Royal Commission, granted the workmen's demand."

So much for the history of Trade Unions in Great Britain up to the time when the National Conscience found expression in the voice and action of the Legislature, and set the workmen free.

During the past 27 years the British workmen have shown themselves worthy of the confidence reposed in them; and by their conduct they have justified before the whole world the action of the Nation's Legislature in granting them the freedom they now enjoy.

My notes on the history of Trade Unions would hardly be complete without some reference to the labour struggles in the United States, and on the Continent. I have dealt most fully with the evolution of Unionism in Great Britain, because there we find the best illustration we can obtain of Unionism as a factor in Social Evolution, for there we have a land

"Where freedom broadens slowly down
  From precedent to precedent;
Where faction seldom gathers head,
  But by degrees to fulness wrought
  The strength of some diffusive thought
Hath time and space to work and spread."

The era of the Civil War—we are told by Dr. Ely, in his History of the Labour Movement in America—brought into prominence, with other matters of importance, a vast number of labour problems, due to fluctuations of the currency, to rapid changes from prosperity to adversity, and also to the sudden and marvellous accumulation of wealth in the hands of successful business men and lucky adventurers. "Never before," he writes, "were there such sharp contrasts in the country between riches and poverty. . . . . Two other especially weighty circumstances must not fail to be mentioned. First, the concentration of the labouring classes in large establishments in great industrial centres had continued without interruption; second, during the war, native labour had in many quarters been replaced by foreign labour, and race antagonism added intensity to the natural struggle between employer and employed."

To these causes we may trace the organisation of labour in America.

"Most trades," writes Mr. Washington Gladden, in his article on "Social Problems in the United States" (*Subjects of the Day*, Aug., 1890), "are now organised; there are also trades assemblies in which some degree of co-operation between the trades is secured, and one National Society, the Knights of Labour, has been formed, whose ambition it is to gather into its ranks all classes of labourers, organised and unorganised. But," he continues, "if any compact union of the labouring classes is to be secured, it is likely to take the form of a federation of Trades' Unions, rather than that of one comprehensive labour organisation into whose local unions labourers of all classes shall be promiscuously gathered."

I need not follow the growth of the labour movements in America much further. Suffice it to say, that for the six years ending 1866, strikes and lock-outs occurred, and battles were fought in the interests of labour involving a cost to the employees amounting in round numbers to twelve millions sterling.

"One result of the labour war of 1886," says the writer last quoted, "was the introduction into a considerable number of establishments of the principle of participation in profits. . . . Since that date the movement has been steadily gaining ground; the success of some of the experiments has been notable, and there is a fair prospect that the system of participation will gain a firm footing in our industrial Society. That it is logically the next stage in the evolution of labour seems obvious."

On the Continent, the workers have to win their right to combine for the protection of their mutual interest. They are as yet only experiencing the throes of the political birth-pang that will ultimately give them the liberty they are aiming at.

I turn now to the second portion of my paper in which I wish to deal briefly with the tendency of Trade Unions.

When it is remembered that "associative effort"—taking shape in Trade Unionism—has been the "natural evolution of generations of increasing political freedom," and that each form of industrial association is that most suitable to the conditions under which it originates and lives, I think it will also be admitted that the present potentialities of Unionism need give us no alarm for the future.

I hold with Mr. William Clark—one of the contributors to the interesting "Fabian Essays," (p. 62), "that there *has* been, and *is proceeding*, an Economic Evolution, practically independent of our individual desires or prejudices;" and holding this as an article of my political faith, I do not contemplate the future of Unionism with fear or misgiving.

Unionism, like the individual, has to spell out its way in syllables of painful experience, but the fact that it has sometimes seemed to blunder and fail has no more been an indication of weakness or want of vital strength than is the falling back of a ripple on the sandy shores an indication that the waters are receding from their work of drawing down the "dust of Continents to be."

> "No doubt vast eddies in the flood,
> Of onward time shall yet be made,"

but are the eddies any indication that the waters are not passing onward? Nay! do not the eddies create the very force necessary to carry them forward?

Let us not, then, judge Unionism by the apparent mistakes that have been made, but rather by the sun-lit milestones that have marked its progress.

On pages 427-9 of his history, Howell gives a list of nearly 60 important Acts which were more or less the outcome of the combined action of the Trade Unions during the years 1869 to 1889; and even this list, it is admitted, gives but a bare record of the direct results of the action of the Unions and Congresses, and, more recently, of labour representation in the National Parliament, where the voice of Unionism is now listened to with respect, and its influence made manifest. As Howell has pointed out, however, "it is not so much in specific performances that the record of Trade Unions is seen to greatest advantage. It is rather," he says, "in those unrecorded fields of labour which constitute the everyday life-work of the Unions that they display their power, wield their influence, and achieve their more permanent successes. The improved condition of the working classes to day is largely due to their efforts. The improvement has been slow—terribly slow; and it is not so apparent to the younger generation as to those whose age and experience takes them back to the "forties" and "fifties" of the present century. The progress, nevertheless, has been real and substantial in material advantages—wages and hours of labour; in social position, by the recognition of industrial rights; in political status, by enfranchisement and election to the highest posts open to popular election; in constitutional rights and judicial obligation by the repeal of repressive and disabling laws, and by the enactment of more just and equitable enabling laws . . . and even in the administration of justice the position of workmen has improved enormously." This writer strongly emphasises a fact that he declares has hitherto been lost sight of by economical writers, and that is, "the higher duration of life attained by the members of the Unions in recent, compared with former, years." He gives striking statistics in support of this assertion, and points to the important consideration that this longer duration of life speaks volumes as to the present improved conditions of life and labour—that the homes and circumstances of the people must be better, for the wives share in the longer duration of life, and that the improved conditions of the heads of the family cannot fail to exercise a beneficial influence upon its younger branches.

Above all, it has been the tendency of Unionism to bring more prominently under notice the absolute necessity that exists for a wiser allocation of labour, if misery is to be banished from the ranks of the working classes. This is the problem towards which associative effort must turn its almost undivided attention in the immediate future. Almost without consciousness of the fact the Trade Unions have been working out the answer to the riddle, working it out, it may be, through much travail and suffering, but with a growing demonstration of the fact that "the end will crown the work."

What are the avowed objects of Trade Unions? I do not ask upon what grounds we may justify their existence, for their existence is explained in the fact of their adaptibility to the economic conditions under which we live. Trade Unionism takes it place as a natural and necessary factor in the evolution of social life, for as Jevons nicely puts it in his little work on "The State in relation to Labour" (p. 88), "Common trade interest is one of the strongest bonds of society, and, judged by the light of history, is likely always to be a considerable factor in social affairs."

"In their essence," writes Howell, "Trade Unions are voluntary associations of workmen for mutual protection and assistance in securing generally the most favourable conditions of Labour. This is their primary and fundamental object, and includes all efforts to raise wages or prevent a reduction in wages; to diminish the hours of labour, or resist attempts to increase the working hours; and to regulate all matters pertaining to matters of employment or discharge, and modes of working . . . The sphere of their action extends to almost every detail connected with the labour of the workman and the well-being of his everyday life."

Such aims and objects as these must necessarily have a tendency for good, and if in striving to give effect to the ideals they "stretch lame hands of faith to reach" the Trade Unions sometimes get caught in the eddies of the flow-tide of Social Evolution, the experience is wholesome, and must be recognised as an essential factor in their progress. In this fact lies our hope for the future. Each mistaken effort of misused strength in the past has taught them lessons of wisdom that will certainly be taken advantage of, and turned to good account in the future. Every conflict that now takes place between Capital and Labour, and all the experience of the troublous past, goes to demonstrate beyond any room for doubt that the objects and aims of Trade Unions must be attained peaceably, or not at all; that their work must be carried out upon constitutional lines, and must find a response in the National Conscience if it is to bear the fruit they hope to pluck.

In the fact that the Unions must, as a matter of experience, get to recognise these truths, lies our guarantee of the benign influence that associative trade effort is likely to exercise in the future.

It will be remembered that in my opening remarks I referred to the broadening of the ties of kinship into a realisation of the duties between man and man that finds expression in a brotherhood based on the foundations of social duties and relationship.

In the gradual evolution of the highest civilisation there must necessarily be different phases of social relationship. The phase we have now entered upon is being largely moulded and shaped by the influence of Trade Unionism, and I do not think there is anything to regret in our forced admission of this fact. For, if the human race is progressing, and not retrograding, then, surely, the recognition of the fact that Trade Unions have become important factors in the development of a higher civilisation is sufficient demonstration in itself that the tendency of Trade Unionism is for good and not for evil.

The more immediate tendency of associative effort on the part of the working classes appears to my mind to lie in the direction of a fairer apportionment of the world's wealth, and a wider recognition of equality and brotherhood than has yet been realised in the world's history.

The present strife between Capital and Labour cannot continue for ever. Each conflict has but served the purpose of bringing the contending parties closer together, and the time cannot be far distant when they shall stand face to face, and agree to live and work together in unity of purpose for a mutual good.

That is what I see in the immediate future as likely to result from the victories of Trade Unionism in the past, and its influence at the present time—an Industrial Partnership, in which, social distinctions being set aside, the skilled workman will work hand to hand with the man of capital, and each will share the just profit of his enterprise and skill.

And, far away beyond this, I see the development of a social life in which associative effort will have played a not unimportant part, the ideal Socialism of One

"Who wrought
With human hands the Creed of Creeds
In loveliness of perfect deeds."

NOTES ON TASMANIAN CRUSTACEA, WITH DESCRIPTIONS OF NEW SPECIES.

By Geo. M. Thomson, F.L.S.

(Corresponding Member Royal Society of Tasmania).

When in Tasmania in January of this year I collected a few specimens of Crustacea in the neighbourhood of Hobart, and also obtained others from Messrs. A. Simson, of Launceston, and L. Rodway, of Hobart. Since my return to New Zealand several specimens have been forwarded to me by Mr. C. Chilton, who obtained them from Mr. R. M. Laing, and a number of others have been received from Mr. Morton.

As far as I am aware, no one in Tasmania has devoted special attention to the Crustacea, though a few species have been described in foreign publications from material gathered in the colony. In the "Catalogue of Australian Stalk and Sessile-eyed Crustacea," by Prof. Haswell, of Sydney, which was published in 1882 by the Trustees of the Australian Museum, 42 species are recorded (and 41 described) from Tasmania. Seven more are described as occurring in Bass Straits, some of which are no doubt to be found on the Tasmanian shores. In the various reports of the collections made by the "Challenger" expedition several additional species are also recorded from Bass Straits, to which the same remark applies.

Only *four* of the previously described forms are fresh-water species, namely: *Astacopsis franklinii* and *A. tasmanicus*, *Engæus fossor* and *E. cunicularius*, all fresh-water crayfishes. The latter genus is found in Gippsland as well as in Tasmania. Judging by past experience as to the limits of variation among fresh-water crayfishes, it will probably be found on further examination that the two Tasmanian species of *Engæus* are not entitled to rank separately; Erickson's descriptions are not very satisfactory.

The collection examined by me includes 22 species. Of these only 5 have been recorded in the Catalogue of the Australian Crustacea; 10 have been already described from other parts of the world, but are now recorded for the first time from Tasmania, while 7 are quite new and are described here for the first time. In an appendix I add a species described by Budde-Lund. These additions bring the total number of species now known to occur in Tasmania to 58. It is manifest that this represents only a fraction of the forms which must occur in the colony.

The most interesting of my finds is certainly the Schizopod shrimp (*Anaspis*) found in pools at the top of Mt. Wellington. How an animal of such conspicious size should have hitherto escaped the observation of collectors, occurring as it does in a locality which residents, as well as visitors, to Hobart visit in numbers every season, is only another proof of the small amount of attention which has hitherto been paid to this section of the Tasmanian fauna.

This animal is, I think, one of the most remarkable Crustaceans found of late years. How and when its ancestors reached its present habitat is one of those questions which we have no present means even of guessing at. Its nearest allies—and even they are very distantly related—appear to be among the Euphausiidæ, a deep sea group of Schizopoda. But the whole structure of the animal has become so profoundly modified from that of all known Thoracostraca, that I think we must assign it a very high antiquity. To take only two of its most prominent characteristics, it has completely lost the shield or carapace so distinctive of all other animals of the order Thoracostraca, and no doubt in association with this its gills have become plate-like and project externally along the sides of the thorax. The loss of the carapace is the feature which has suggested the name *Anaspis* to me. In respect to this feature, and also in its gills, the animal resembles an Amphipod, the resemblance being, however, purely external and having no importance. It is this feature again which suggests the great antiquity of the form, for among all the Thoracostraca the carapace appears at an extremely early stage of the development of the individual, and is present in all the sub-orders. In the Euphausiidæ the young animal is hatched as a Nauplius with a large well-developed carapace. At what stage of its development *Anaspis* loses its carapace, or has already in the course of its evolutionary history lost it, is a question which I am unable at present to solve; meanwhile I think it advisable to create a new family Anaspidæ (Tribe Schizopoda) for its reception.

The occurrence of fresh-water Amphipoda of the genus *Niphargus* is another point of great interest. *N. montanus* seems common enough in the smaller pools and among the swampy ground on the top of Mt. Wellington. I did not find it in the large pools with *Anaspis;* the latter would, perhaps, exterminate it in such open localities. I collected *N. mortoni* originally in a small rill at an elevation of only 200 or 300 feet above high-water mark, at Franklin on the Huon, and was at first under the impression that it might prove only a transitional form between a littoral and a fresh-water species. But it appears to be abundant in the streams coming down the seaward side of Mt. Wellington at elevations of 2000 feet and more. It is just questionable whether my specimens are strictly referable to the genus *Niphargus*, occurring, as the latter does, only in the subterranean waters of Europe. The genus is probably of considerable antiquity, for it has undergone a good deal of modification. *N. montanus* is also probably of very considerable age as a species, for not only does it occur at a much greater elevation than *N. mortoni*, but it has also undergone greater modification of structure. It would aid us, perhaps, in the elucidation of this problem if all the fauna of the pools on Mt. Wellington were to be examined. The researches conducted by Mr. Chilton and myself on the New Zealand Crustacea have brought to light some interesting facts in this connection. For example, of fresh-water Amphipoda and Isopoda there are eight known species in New Zealand, three of which occur in streams, etc., and five are subterranean—of the former, *Idotea lacustris* ranges from brackish waters, just above tide-marks, to a height of 1200 ft. The species belongs to a genus having several marine representatives in the New Zealand, and is apparently identical with a form found in the Straits of Magellan. Our species therefore is apparently in course of development into a truly fresh-water form. One species of *Pherusa* (marine) occurs in the shallow coastal waters, another, very different, has only hitherto been found at elevations of 2000 feet, quite 100 miles from the sea. One species of *Calliopius* is marine (littoral), one occurs in fresh-water streams, and a third in the underground waters of the South Island. On the other hand, *Gammarus fragilis, Crangonyx compactus, Phreatoicus typicus*, and *Cruregens fontanus* are all species occurring only in subterranean waters, and of which no related marine species have been found. They have very probably been long isolated, especially the two last, and have undergone a very considerable amount of modification. It may ultimately be possible to trace the developmental relations of several of these fresh-water forms from allied marine forms now occurring in the adjacent seas, and this is being gradually done in New Zealand. In the case of Tasmania however, so little is yet known of the Crustacean fauna, that any speculations as to the origin of the fresh-water forms are premature. In light of the finds recorded by me, however, naturalists will wait with some impatience for further researches on the fresh-water fauna of Tasmania.

The terrestrial Crustacea are of very great interest as bearing on the question of geographical distribution. *Talitrus sylvaticus* is an Amphipod common to Tasmania and the eastern parts of Australia. It is the representative in damp woods of the New Zealand *Orchestia sylvicola.* How widely these species differ, or whether they are not indeed too closely allied to be separated even specifically, is still an undetermined point, the whole relationships of the Orchestidæ requiring to be carefully worked up. *Oniscus punctatus*, the common wood-louse of the bush, found along with the last species under dead leaves, etc., is also common in New Zealand, where it is associated with *Orchestia sylvicola*. *Porcellio graniger*, another common wood-louse of New Zealand, and which has also been recorded from Tasmania, is not, as a rule, found in the damp bush in the eastern colony. It affects drier situations, and is the species which frequents houses and gardens. It may prove to be a cosmopolitan species. It is certainly likely to be widely spread by artificial means, as New Zealand and Tasmanian ferns and other bush plants, especially when packed for export in nurserymen's establishments, are almost certain to contain specimens. The question requires examination. Gustave Budde-Lund (Crust. Isop. Terrestria) thinks that probably this species does not differ from *P. lævis*, a form found in nearly every country of the world.

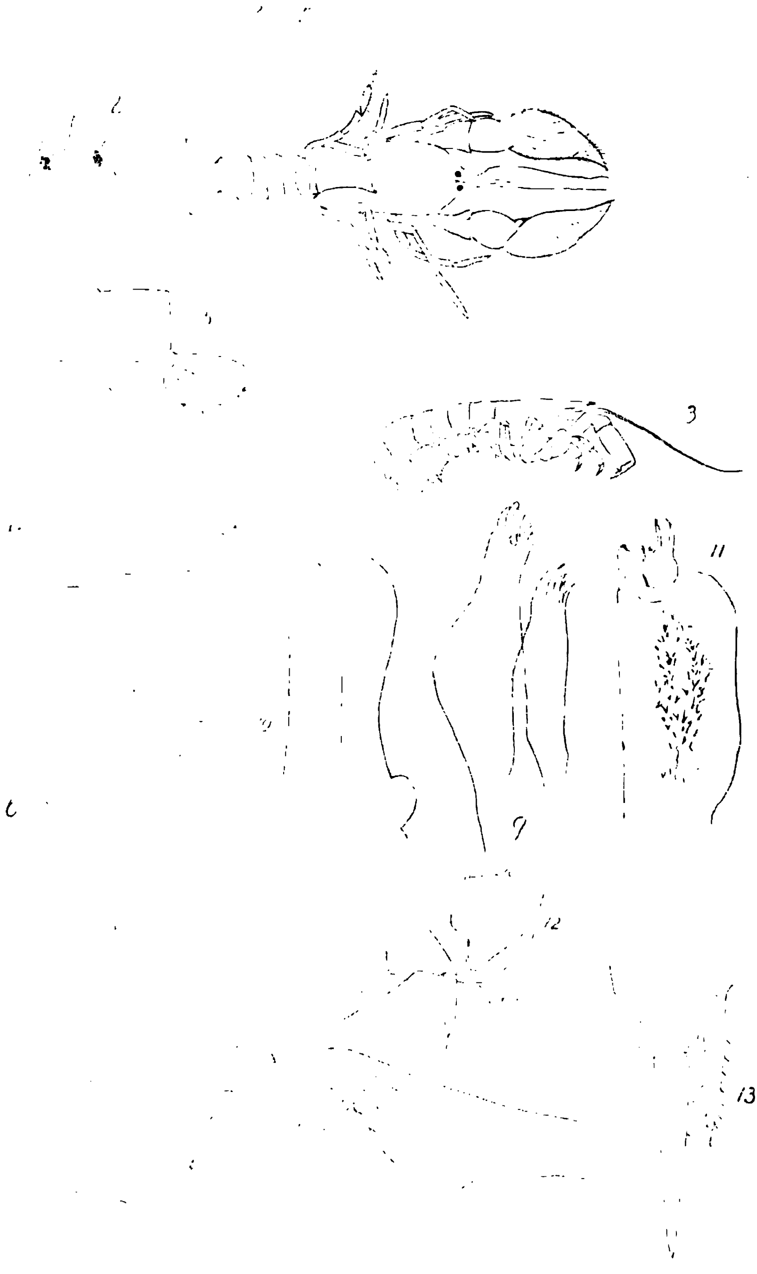
I have, in this paper, described the new species of Amphipoda at—what may appear to some to be—undue length. But in face of the confusion which has arisen in the past from imperfect descriptions of species of this group, I think it better to err in the direction of minute treatment than to leave in doubt the characters of the forms which are being described.

The following species are described here for the first time:—

Gebia simsoni.
Anaspis tasmaniæ
Rocinela spongicola
Lysianax stebbingi.
Atyloides tasmaniæ.
Niphargus mortoni.
——— montanus.

The following species, already described, are here added to the fauna of Tasmania:—

Pinnixa faba, Dana (Australia, etc.)
Petrolisthes elongatus, Heller (Australia & New Zealand).
Leander intermedius, Stimpson (Australia).
Oniscus punctatus, mihi (New Zealand).
Ligia australiensis, Dana (New South Wales).
Actœcia euchroa, Dana (New Zealand).
Sphæroma gigas, Leach (Kerguelen Island, Australia, New Zealand, Auckland Islands, Falkland Islands, Tierra-del-Fuego).
Iais pubescens, Dana (Kerguelen Island, New Zealand, and Tierra-del-Fuego).



Hyale rupicola, Haswell New South Wales).
Mæra fasciculata, mihi (New Zealand).

Tribe *Brachyura.*

Fam. *Pinnotheridæ.*

1. *Pinnixa faba.* Dana.

I picked up a single specimen (female) of this small crab on the beach near Hobart, and Mr. Morton has sent me a number collected by himself from mussels, also all females. I follow Prof. Haswell in assigning my specimens to this species, though it seems questionable to me whether all the species of *Pinnixa* and *Pinnotheres* are not referable to one and the same slightly varying form. This species appears to be common enough about Hobart, though it has not previously been recorded from Tasmania.

Tribe *Anomoura.*

Sub-tribe *Porcellanidea.*

2. *Petrolisthes elongatus.* M. Edw.

Specimens of this shore crab, so common on the coasts of New Zealand, were found under stones between tide-marks on the beaches in the neighbourhood of Hobart. It has not previously been recorded from Tasmania.

Tribe *Macroura.*

Fam. *Callianassidæ.*

3. *Gebia simsoni.* Nov. sp. (Pl. I., figs. 3—5.)

Front three-lobed, the carapace being produced in the median line into a blunt rostrum, and the margins also produced forwards into acute points. The anterior portion of these margins and of the rostrum are crenately toothed and somewhat hairy. External antennæ three-fourths as long as body, internal pair having the peduncle reaching as far as the peduncle of the external pair; both flagella extremely short. First pair of legs very stout; mesos broad and flattened, with about four small teeth on its lower distal margin, and one on its upper margin near the end; carpus with one strong tooth on the lower inner margin; propodos elongate sub-quadrate, the lower margin produced into a long stout tooth; palm transverse; dactylos nearly straight, acute, very hairy, and twice as long as palm.

In the general form of the front of the carapace (fig. 4), this species resembles *G. spinifrons* (Haswell), but is distinguished by the almost total absence of spines by the form of the hand in the first pair of legs, and by the absence of distinct epimeral thickenings on the sides of the abdominal segments. The legs of the second to the fifth pairs are destitute of spines, but have the carpus, propodos, and especially the dactylos somewhat thickly furnished with hairs. The telson (fig. 5) is short, very broadly rounded, and is thinly membranous in texture. The external plate of the last pair of pleopoda broadens posteriorly, and is strengthened by two stout nearly parallel median ridges in addition to its marginal thickening; the internal plate is obliquely fan-shaped, and is strengthened by one median ridge. Length 44 mm. (1¾ inch).

A single specimen was handed to me by Mr. A. Simson (after whom the species is named), who obtained it on the East Coast. It is a female, having the whole under surface of the abdomen covered with ova.

Fam. *Astacidæ.*

4. *Astacopsis franklinii.* Gray.

A few small specimens of this common freshwater Crayfish, obtained at Zeehan (?), were handed me by Mr. Simson. Gray's short description reproduced in the Australian Museum Catalogue (p. 176) is substantially accurate. In none of my specimens, however, were "the sides of the second abdominal rings spinose." On all of them examples of the parasitic *Temnocephalus qudricornis* (Haswell) were found.

5. *Engœus cunicularius.* Erichson (Pl. I., figs. 1 and 2).

Specimens of this small freshwater crayfish, collected at Zeehan (?), were handed me by Mr. A. Simson. The name is wrongly printed *E. cunicularis* in the Australian Mus. Cat. It differs from *E. fossor,* according to Erichson (Archiv fur Naturg., 1846, p. 102) not only in the absence of a toothed border on the lower side of the hand, but also in its more rounded carapace, its broader rostrum, larger eyes, sharp-pointed antennary scale, and in the greater breadth of the posterior part of the abdomen. In the absence of examples of *E. fossor,* I cannot compare the two forms, but the characters seem hardly good enough to found a specific distinction upon.

My largest specimen was 1¾ inches in length from the point of the rostrum to the extremity of the caudle swimmerets; the chelæ were about 1½ inches long. In the figure (fig. 1) the relative narrowness of the abdominal segments as compared to the carapace is not brought out. The carapace is deep relatively to its breadth, and in general appearance the whole body is much compressed, The carapace is produced in front into a minute sharp rostrum (fig. 2), reaching slightly beyond the eye-sockets, and on the upper part of it are two minutely setose ridges which converge towards it extremity. The eye-peduncles are very short, and the acutely-pointed scales of the outer antennæ hardly reach beyond them. The whole body is nearly smooth, and there are only a few small hairs on tho outer joints of the legs.

Fam. *Palæmonidæ.*

6. *Leander intermedius.* Stimpson.

A single specimen of this prawn—a female carrying an immense number of ova beneath the abdomen,—was obtained on the East Coast by Mr. A. Simson. The species has not been recorded from Tasmania before.

Tribe *Schizopoda.*

Fam. *Anaspidæ,* fam. nov.

Carapace wanting; the cephalon and all the segments of the body distinct. Maxillipeds and succeeding seven pairs of legs nearly uniform in structure, adapted for walking. Branchiæ lamellar, all external. No egg-pouch. Pleopoda with well-developed natatory exopodites; endopodites of first and second abdominal segments, specially modified in the males as copulatory appendages. Uropoda, normal. Development?

Genus *Anaspis,* gen. nov.

Integument thin and flexible. Whole body divided into fifteen distinct subequal segments, viz., cephalon, eight thoracic, and six abdominal. Eyes well developed. First antennæ, with three-jointed peduncle and two flagella. Second antennæ, with well developed scale on the second joint. Mandibles with three-jointed palpi. First maxillæ two-branched; second pair four-branched. Maxillipeds pediform, with two rudimentary branchiæ projecting externally from the coxa; exopodite small and rudimentary. Legs generally uniform in structure, seven-jointed, each furnished with a claw-like dactylos. The coxa of each leg (except those of the last pair) bear two external lamellar branchiæ which project forward, and the basos bears a well-developed natatory exopodite. Genital opening of the female on the sternum in front of the last pair of thoracic legs. Telson short, rounded. Uropoda with the plates subequal; inner with a slight longitudinal median ridge; outer, with an imperfect transverse articulation near the middle.

7. *Anaspis tasmaniæ,* sp. nov.

The characters of this remarkable and interesting shrimp—the only truly freshwater schizopod I think yet found—are briefly expressed in the diagnosis of the genus. A few details may be added here, but I propose elsewhere to describe the animal more fully, and to discuss its affinities.

The cephalon is hardly larger than any of the body segments, and is produced in a very short acute rostrum between the bases of the antennæ; its sides are sub-equal in depth to the succeeding segments. The first thoracic segment alone has its sides divided by a very distinct and somewhat oblique line into a broad epimeron; none of the other segments bear any traces of epimera. The lateral margins of all the thoracic segments but the last are more or less covered by the plate-like branchiae of their respective segments, which are all external to the body and project forwards. The abdominal segments are somewhat longer than the thoracic; their margins are smooth, except the two last, which are slightly fringed with short tooth-like spines or setæ.

The cephalic segment carries the ophthalmites, two pairs of antennæ, the mandibles, and two pairs of maxillæ. The first thoracic segment carries the first pair of walking legs, which are the modified maxillipeds. Each of the succeeding segments bears a pair of appendages, those of the thorax acting partly as walking legs and partly as natatory organs, and those of the abdomen as natatory organs. The telson is bluntly triangular in form, slightly ridged down the median line and thickened along its outer margins; the posterior rounded margin is furnished with a comb-like row of short spines.

The eye-peduncles are short, one-jointed, and directed obliquely outwards. The antennæ of the first pair have a three-jointed peduncle, the joints of which are broad and rather flattened. The last joint bears two flagella, the outer of which is composed of a great number of articulations—usually from 75 to 100—and is from two-thirds to three-fourths the length of the whole animal; the inner is less than one-fourth the length of the animal, and is divided into from 20 to 25 articulations only. The *second antennæ* have a four-jointed peduncle, with a long multi-articulate (50-60 joints) flagellum, the first joint of which is probably, however, to be reckoned as the fifth of the peduncle. The moveable plate at the end of the second joint is oval, and has a smooth margin fringed with long plumose setæ. The flagellum is about two-thirds as long as the body of the animal.

The *mandibles* are strongly developed and are placed so as to close the mouth opening with their exposed part. The cutting edge is furnished with a double row of strongly indurated teeth, and at right angles to it stands the large oval grinding tubercle. The *first maxillæ* are two-branched only, the outer branch ending in a double row of strong spines which are pectinately toothed on the inner side, and the inner branch, which is both smaller and more rounded, being fringed with short plumose setæ. The *second maxillæ* are four-branched, each branch being one-jointed. These two pairs of organs appear to be purely masticatory in their function and to differ from those of other Schizopods, not only in the number of their articulations, but also in the total absence of any external appendages. The *maxillipeds* are similar in general form to the succeeding pairs of legs. They are very distinctly seven-jointed, and bear on the inner side of the coxal joint two small lamellar organs fringed with setæ, and which appear to act as masticatory lobes subsidisary to the maxillæ. These resemble in a more highly developed form the masticatory lobe found on the corresponding joint on the maxilliped of most species of the Euphausiidæ. On the outer side of the coxa are two small lamellar branchiæ, while the basos bears a short slender one-jointed exopodite which just shows at its extremity traces of the articulation which characterises the same organ in the succeeding appendages. The dactylos of this limb (and of nearly all the succeeding pairs) ends in two or three powerful hooked claws which are almost hidden among setæ.

The other seven pairs of *walking legs* increase in length up to the fourth, which is the longest, and then gradually decrease in length and robustness to the last. The branchiæ, which greatly resembles the same organs among ordinary amphipod crustaceans, undergo a somewhat similar progression and diminution in size, but are quite wanting on the last pair. The exopodites or natatory branches increase in size relatively to the limbs which bear them from the first up to the sixth pair, in the seventh they are reduced to small branchia-like processes, quite destitute of segmentation, in the eighth they are quite wanting

The five pairs of *pleopoda* are all similar in form in the females. Each consists of a basal joint carrying a large natatory exopodite near its outer angle, and a small lamellar endopodite, like a rudimentary gill, on its inner angle. In the males the endopodite of the first pair is developed into a lamelliform plate, projecting inwards and apparently furnished with a duct, while the corresponding limits of the second pair are produced into two scoop-like processes, with their hollow faces meeting in the median line. I have not discovered the use of these organs. The sixth pair or *uropoda* are developed into a large tail-fin as in most Schizopods, but owing to the shortness of the telson this is formed of four (not five) plates. The plates are sub-equal in length, narrow-oblong in form, and are fringed with long comb-like setæ. The outer plates are ridged on their outer proximal margins, and are partly divided by a transverse ridge defined by a row of short spines. The telson is short, rounded and toothed round the end.

Large specimens are about 1½ inches in length, the average length being about one inch.

The colour is grayish, becoming brown in spirit specimens.

I discovered these remarkable shrimps in a pool near the top of Mount Wellington, that is, at an elevation of over 4,000 feet. The pool had deep crevices among the boulders, and in these dark recesses large specimens seemed to be abundant, but they were shy and difficult to capture. Crumbs, etc., dropped on to the sloping rock bottom of the pool attracted them however, and I was able to secure several specimens, apparently all females. This was in January. At my request, however, Mr. L. Rodway visited the spot on the 24th May. The ground was then covered with snow and the pools all frozen over. After breaking the ice, he put in a small net baited like a crayfish net, and as the result of several hours' patient waiting in an extremely cold situation he succeeded in securing a large series of specimens of both sexes and of considerable range of size. I wish to take this opportunity of thanking Mr. Rodway for his kindness to me in carrying out my request with so much enthusiasm.

I believe this form to be the most interesting Crustacean which has been discovered for very many years.

Tribe *Isopoda.*

Fam. *Oniscidæ.*

Sub-Fam. *Oniscinæ.*

8. *Oniscus punctatus*, mihi (Pl. I. figs. 6-13).

This terrestrial Isopod, so common among fallen leaves, etc., in the New Zealand bush, seems to be equally common in similar situations in Tasmania. I obtained some specimens along with *Talitrus sylvaticus* on the slopes of Mount Wellington, and received a number also from Mr. Morton, collected from the same locality. My original description in the Transactions of the New Zealand Institute, vol. xi., is very meagre, and the figure most unsatisfactory; I therefore take this opportunity of amplifying both.

The length of the body is more than twice its breadth, the lateral margins of the segments are rounded, and—except the last—hardly produced backwards. The thoracic segments are unequal in length, the first being the longest, then diminishing to the fifth, which is the smallest, the two last being somewhat longer. The abdomen is about two-thirds as broad as the thorax, and rather more than one-third as long.

The head is short and much narrower and shorter than the succeeding segment, with which it articulates closely; the eyes are small and are placed quite at the sides of the head. Seen from the front the epistome is slightly arched. The first antennæ (fig. 6) are very minute and three-jointed, the third joint being minutely setose at the extremity. The second antennæ (fig. 7) are about as long as the head and first three body segments, they are strongly geniculate; the three-jointed flaggelum is sub-equal in length to the last joint of the peduncle. The mandibles (fig. 8) end in four chitinised brown curved teeth, in addition there stands on the inner side of these a single pale-coloured tooth or tubercle; the cutting edge inside of the teeth bears three tufts of hair-like setæ, the innermost (hindmost) being the longest. The first maxillæ (fig. 9) have the outer plate strongly curved on the outer margin, the distal portion of which carries a dense fringe of fine setæ; the end is furnished with seven (or eight) strongly chitinised teeth, which are dark brown in colour; the slender inner plate ends in five weak slightly curved teeth. The second maxillæ (fig. 10), as in other members of the sub-family, have the two plates anchylosed together throughout their length, and have the extremity of the inner margin produced into a brush-like process. The maxillipeds (fig. 11) have the characteristically large basal plate somewhat rounded on the outer margin, and carrying on the inner extremity a small, nearly square, plate, the rest of the limb not being developed; outside of, and obliquely placed to this, is the small palp of which the basal joint bears two small processes, while the terminal joint is small and is produced into a slightly fringed pointed apex. The large basal plate is always more or less ornamented by dark pigment.

The uropods (figs. 12 and 13), as seen from below, have their appendages very freely articulated to the basal plate, the inner and shorter one being placed usually anterior to the outer; the former has several and the lateral a few small marginal spines.

The species is now recorded for the first time from Tasmania.

Sub-Fam. *Ligiinea.*

9. *Ligia australiensis*, Dana.

This species was found by me in abundance under stones on the beaches in the neighbourhood of Hobart, and several specimens from the same locality were forwarded to me by Mr. Morton. These animals usually occur just above tide-marks, and run with great agility when their hiding places are exposed.

The species has not been recorded before from Tasmania.

Sub-Fam. *Scyphacinæ.*

Actæcia, Dana.

The generic character as given by me (in the Trans. N.Z. Inst. Vol. xi., p. 49), and which I adapted from Dana, is somewhat incorrect. I would alter it as follows:—" External antennæ stout, curved, five-jointed, with a three (or, counting the apex, four) jointed flagellum. Maxillipeds having the palp in the form of a slender acutely-pointed plate. Legs of the seventh pair as long as the preceding pairs."

10. *Actæcia euchroa,* Dana (Pl. II., figs. 1-8).

I found specimens of this little Isopod on the sea-beach between tide-marks at Eaglehawk Neck. They ran rapidly along the sand, and when pursued rolled themselves into a ball. The species is common on the New Zealand coast.

The few specimens found by me were very small, being less than $\frac{1}{6}$th of an inch (4 mm.) in length. In colour they were light gray with irregular black markings. Under the microscope the integument appears to be minutely scale-like, with a few short scattered spinules, particularly on the margins of the abdominal segments and on the appendages.

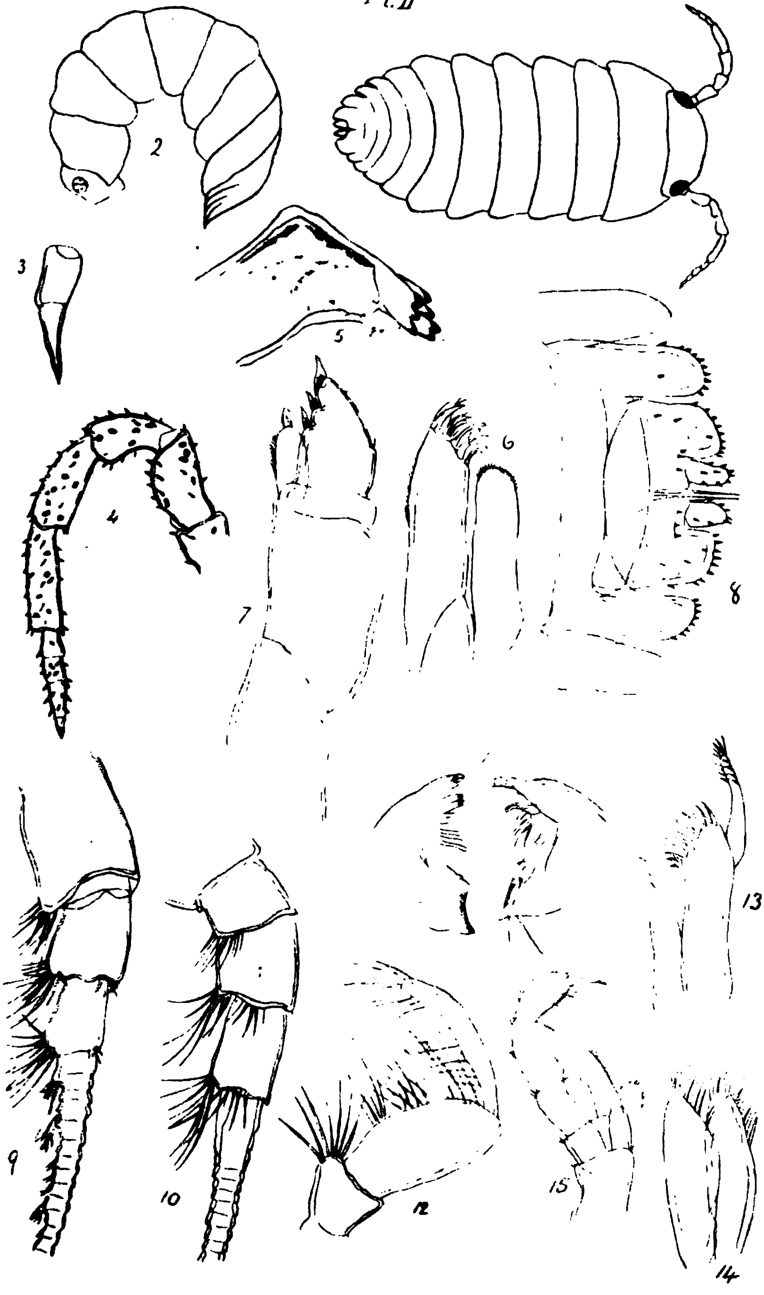
The first antennæ (fig. 3) are minute and indistinctly two-jointed; they are very difficult indeed to distinguish. The second antennæ (fig. 4) have a five-jointed base, with a four-jointed flagellum (counting the apical joint); all the articulations are dotted with numerous short spines. The mandibles (fig. 5) are strong and thick; at the apex is a stout bifid tooth, inside of this there are two simple teeth and then a strong trifid tooth standing at right angles to the cutting ridge of the limb; behind these stands a short comb-like process and a brush of fine setæ.

The first maxillæ (fig. 6) have the outer plate slender but armed at the extremity with about twelve acute curved spines; the inner plate ends in a rounded finely setose edge. (The second maxillæ were not seen, being lost in the dissection.)

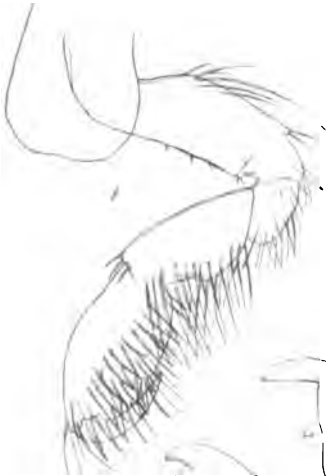
The maxillipeds are stated by Dana to be two-jointed in the scyphacinæ, and the second joint to be lamellate; they are so figured for his *scyphax ornatus* of which he originally took the present species to be the young form. In *Actæcia,* however, they are four-jointed (fig. 7), the basal joint being very short and having the large second joint attached to it obliquely. There is no inner plate attached to the basal joint, but the second joint bears a small oval plate fringed at the extremity. The third joint is short and extremely indistinct, while the fourth is in the form of a flattened, acutely-pointed lamella fringed (not serrately toothed) on its inner edge.

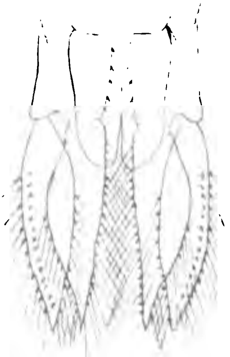
The abdominal segments (fig. 8) are short, the last being

Pl. II



Pl. III





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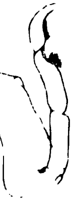

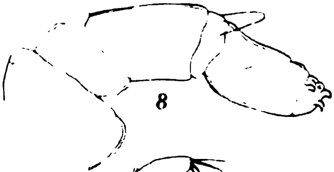

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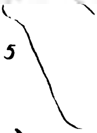

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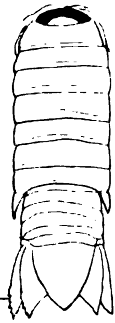

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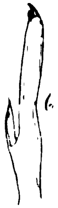

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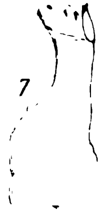

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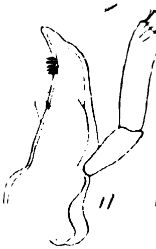

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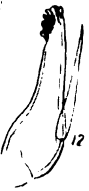

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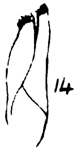

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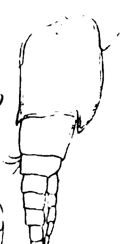

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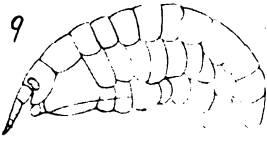

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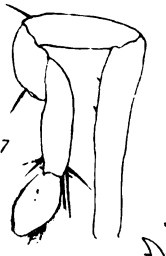

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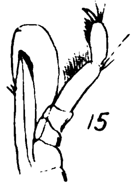

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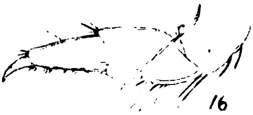

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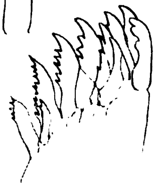

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the shortest of all; the lateral portions of the third, fourth, and fifth are greatly produced backwards, and have their margins rounded and edged with short acute spines. The uropods have a very large basal joint, its outer portion resembling the lateral portion of the preceding segment, but with the inner margin only about half as long as the outer and transversely truncate; the outer rami are stout, blunt, and spinose; the inner are long and very slender, are tipped by a long bristle and have their margins finely scabrous; they appear to spring from the very base of the uropods and lie together in the median line.

The whole appearance of these animals suggests that they may be in reality, as Dana suggested, only young forms, but though I have collected them in abundance on the New Zealand coasts during several years past, I have never met with any other species resembling them.

Harger's genus *Actoniscus* (Amer. Journ. Sci. iii., Vol. xv. p. 373, 1878), must evidently be relegated to *Actoeia*, the characters of which were so imperfectly defined by Dana.

Family *Ægidæ.*

11. *Rocinela spongicola*, n. sp. (Pl. iii., figs. 3-8.)

Two specimens belonging to this genus were sent me by Mr. A. Morton, with the remark that they were found in some sponge which had been dredged; the exact locality, however, was not stated. The following is a description:—

Body (fig. 3) scarcely convex, smooth, narrow, oval in form, the length being three times as great as the breadth. Head short, rounded in front; eyes occupying nearly the whole of the segment, crescent shaped. The thoracic segments increase slightly in length to the sixth, which is the longest. Epimeræ small, those of the last three pairs produced backwards (especially the last) into acute angles. Last abdominal segment triangular, pointed, longer than the anterior portion of the abdomen, setose on the posterior half of the margin.

First antennæ reaching nearly to the end of the thoracic segment, hardly separated at the base by a minute acute process of the cephalon; peduncle and flagellum sub-equal in length, the latter about fourteen-jointed setose, the second joint as long as the three succeeding. Second atennæ half as long again as the superior; joints of the peduncle slightly increasing in length to the fifth, which is the longest; flagellum as long as the peduncle, about fourteen-jointed.

Mandibles (figs. 4 and 5) with the strong basal portion ending in a minutely two-lobed extremity, viz., a sub-acute tooth and a shorter rounded lobe; palp with the joints subequal in length, the last curved setose on its inner margin and capable of folding against the setose inner margin of the second joint.

First maxillæ (fig. 6) with outer plate long and narrow, very slender, and ending in one strong tooth, and three smaller ones; inner plate rudimentary with a minute terminal seta. Second maxillæ (fig. 7) somewhat dilated, ending in a feeble rounded lobe, and bearing on its inner extremity a very small uni-articulated process.

Maxillipeds (fig. 8) pediform, the terminal portion ending in a few (about four) small claws; the palp represented by a very small one-jointed process

The three anterior pairs of thoracic feet are furnished with sickle-shaped dactyli. The four posterior pairs are directed backwards and are elongated; the sixth and seventh pairs are the longest.

The basal part of the caudal appendages is produced backwards on its inner side into a long acute ciliated process; the external ramus is long, narrow, pointed and ciliated all round, it bears a row of spines on its outer margin; the internal ramus is about twice as broad; and is obliquely truncate at its widest part; it is ciliated all round, and bears a row of spines towards the extremity of both margins.

Length of the animal 15mm. (about ⅝ inch.)

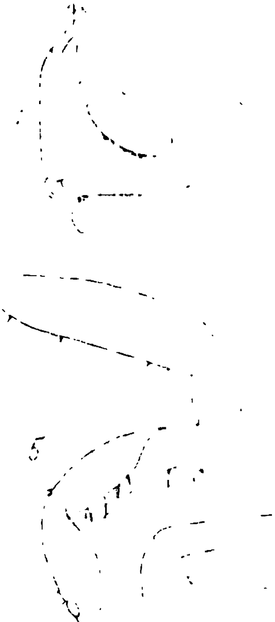
Fam. *Sphæromidæ.*

12. *Sphæroma gigas.* Leach.

A small specimen, which I provisionally refer to this widely-spread Antarctic species, was picked up by me on the rocks between tide-marks at Pirates Bay, and a second from the same locality, collected by Mr. R. M. Laing, was handed to me by Mr. Chilton. It is identical with a species common on the East Coast of New Zealand, but, with them, differs in a few details from a large form, of which I have specimens from the Auckland Islands. In no group of Isopoda is there more need of a thorough revision of the genera and species than in the Sphæromidæ; and identification of many of the described forms is now a matter of extraordinary difficulty. This is chiefly owing to the fact that various naturalists have taken sexual characters as of generic importance, and have, consequently, in many cases placed males and females of the same species in genera. This species has not previously been described from Tasmania.

13. *Sphæroma quoyana.* M.-Edw.

I obtained a solitary specimen of this well-marked species between tide-marks on the Huon River, a little below Franklin. The species was originally described by Milne-Edwards, from specimens gathered on the coast of Tasmania by M. M. Quoy



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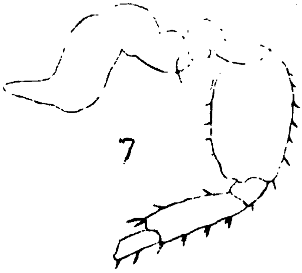

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and Gaimard. It was also found by Heller (Voy. of the "Novara") at Sydney.

Fam. *Asellidæ.*

14. *Jais pubescens.*

Jæra pubescens. Dana: U.S. Expl. Expedn. Crustacea (vol. ii., p. 744, pl. xlix.)

A number of specimens of this little Crustacean were found in the tube in which the specimen of *Sphæroma Quoyana* was placed. According to Dana, the forms originally described by him were taken at Nassau Bay, Tierra del Fuego, parasitic on *Sphaæroma lanceolata.* I have gathered this species at Auckland and Dunedin, and Mr. Chilton has recorded it from Lyttelton, all on the New Zealand coast. Mr. Chilton described his specimens under the name *Jæra novæ-zealandiæ* (Trans. N.Z. Inst., vol. xv., p. 189), the generic name being, however, changed to *Jæra* by Carl Bovallius ("Notes on the Asellidæ." Roy. Swedish Acad. of Sc.) We have since, however, discovered that our New Zealand form agrees with Dana's, and it therefore comes under Bovallius' genus *Jais*, the most distinctive character of which is the tri-unguiculate dactyli of the walking legs.

My Tasmanian specimens agree with those from New Zealand in most points. In Dana's brief description, the first pair of antennæ are said to be 4-jointed; in my specimens they are 6-jointed, which is also the case in the only other species of the genus, *J. Hargeri.*

Tribe *Amphipoda.*

Family *Orchestidæ.*

15. *Talitrus sylvaticus.* Haswell (Pl., iv., figs 1-10).

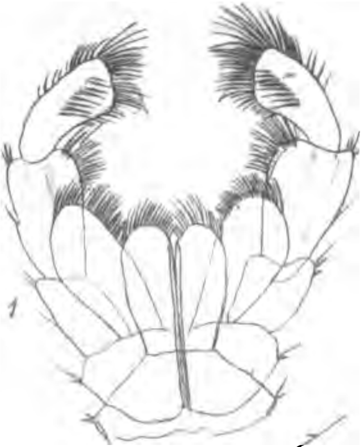
This terrestrial species was originally described from New South Wales, where, according to Professor Haswell, it is "abundant on moist ground, in wood and scrubs." He adds:—"I have received specimens obtained by Mr. Geo. Masters, from Rootyhill (a point about 30 miles from the coast) where it is very common; how much further inland its range may extend I have no exact data to enable me to determine; probably it is confined to a maritime belt of moderate breadth, as I am informed that it is not met with in the far interior." I think that perhaps the long and severe droughts, to which the interior of Australia is liable, would prove more effective barriers against the spread of Amphipoda, than either distance or even ranges of mountains. He goes on to say: "I have never observed it on the sea-shore." The Tasmanian specimens in the Australian Museum, Sydney, originally described by Haswell as *T. affinis*, were collected by

Mr. Kendall Broadbent, but no precise locality is given. Mr. C. Chilton writes me (June 13th, 1892): "I have an abundance of specimens from two situations on the Mount Kosciusko plateau"; these were collected by Mr. R. Helms. I collected several specimens among dry leaves, moss, etc., in the bush on the slopes of Mt. Wellington, a short distance above "The Springs," at a height, therefore, of about 2500 feet; and I have since received numerous specimens, collected by Mr. Morton from the same locality, as well as from other parts in the neighbourhood of Hobart.

By the kindness of Prof. Haswell, I have been enabled to compare my specimens with types of the New South Wales form, to note any differences, and to amplify the description in the catalogue of the Australian Crustacea.

Both pairs of *antennæ*, as is the case in most or all Amphipoda, vary considerably in length and in the number of the joints of the flagella, according to the age of the individuals. This character, it seems to me, has generally been accorded too much importance as a basis of classification in this group. The Australian specimens, however, are more strongly setose than the Tasmanian, and this feature prevails throughout most of the appendages. The *upper lip* is large, rounded and prominent. The *mandibles* (fig. 1) are slightly different in the two forms, my Tasmanian specimens having the molar ridge more prominent and less cup-shaped than the others, while the ciliated spines are fewer. The *lower lip* (fig 2) is of a more or less uniform type in all Orchestidæ; the outer edge has a finely corrugated border, which is very marked in some of my specimens. The *maxillæ* are normally developed; the *first pair* (fig. 3A) have the outer plate ending in about ten stout spines toothed on their inner edge, while the inner plate is slender and ends in two short spines; the *second pair* (fig. 3B) have both plates rounded at the end and fringed with fine spines. The *maxillipeds* (fig. 4) do not quite agree with Haswell's description; the inner plates are tipped with two rounded teeth (between which stands a seta) with a small tooth on the inner side; the outer plates, which are more slender and extend forward a little further, end in two short setæ; the three succeeding articulations—forming the so-called palp—become slender proximally and bear very few setæ, while there is only the rudiment of a blunt terminal joint (dactylos ?). The *posterior gnathopoda* (fig. 6) in the male show some points of difference—best seen by reference to the figures. The dactylos is rounded, and the point of contact with the margin of the propodos marked by a few minute hairs. The propodos tapers to a rounded end, and its upper edge is thin and flange-like, as are the projecting processes of the carpus and meros. In my Sydney specimens (fig. 5) the flanges on the lower side of

Pl. V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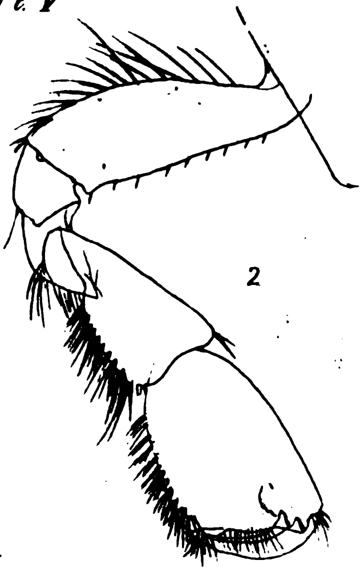
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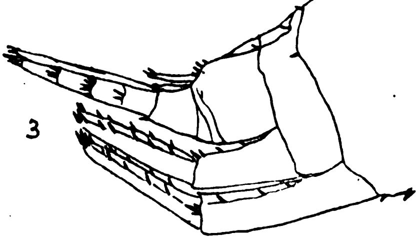
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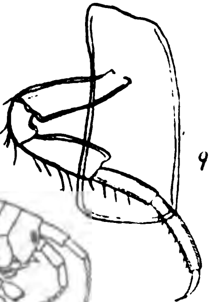
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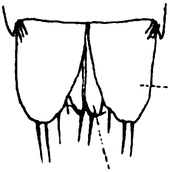

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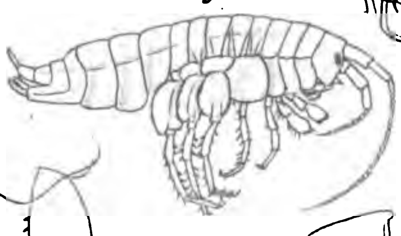

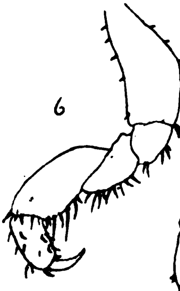
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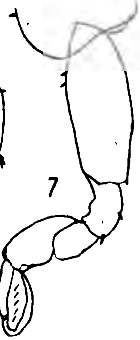
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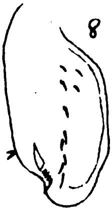
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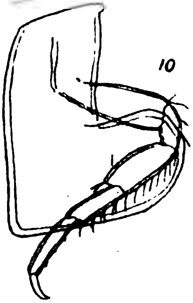
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the carpus, and the tubercular projection of the meros are protected by a few small spines. In the Mt. Wellington specimens, on the other hand, the flanges on the carpus are thinner and more flattened; the meral projection is also flange-like and rounded, and the whole limb is almost destitute of hairs. The *pereiopoda* are generally simpler and less spinous in the Tasmanian than in the N.S. Wales form. The branchiæ of the *fifth* pair in the males (fig. 7) are peculiarly modified. I cannot find any reference to this structure in any other of the Orchestidæ, and would provisionally suggest that they serve as a sort of clasping organ to assist in copulation. In the largest specimen examined they were curled up, instead of being somewhat flattened, as they appear in the figure. I am not sure, also, whether they are equally developed on both sides of the body. The *pleopoda* are reduced to a very rudimentary condition. The *first* pair (fig. 8) have both branches developed, but they are small and feeble, and the setæ are extremely slender; the *second* pair are still smaller and more feeble, while I have failed to find the third pair at all in those specimens examined. This defective condition is probably due to the terrestrial habits of these Crustacea, as in aquatic Amphipods these appendages serve as swimmerets, and aid the animal in forward progression. In terrestrial forms this function being no longer required, the necessity for the organ ceases, and it has accordingly retrograded in its development. The three pairs of *uropoda* (posterior pleopoda of most authors) are much as figured in Haswell's original paper (Proc. Linn. Soc. N.S.W., vol. iv., pl. vii., fig. 1) the ante-penultimate pair being much the longest, and reaching furthest back. The *telson* (fig. 9) appears to me to be quite entire, rounded at the extremity, and furnished with *three* small spines on each side. There is a delicate longitudinal median line visible with a high power, but this is due to the paired organs underneath showing up through its semi-transparent substance. I can detect no trace of cleavage of the organ. Close underneath it lie the very short ultimate *uropoda* (fig. 10) with their conical terminal joint, ending in a single spine. Looking at the telson from above, the extremities of these appendages slightly protrude, and this, probably, led Prof. Haswell to conclude that the telson was "cleft in the middle line posteriorly."

The specimens found by me were yellowish or yellowish-brown in colour. The largest was $\frac{4}{10}$ inch (or 10 mm.) in length.

16. *Talorchestia diemenensis.* Haswell (Pl. v., figs. 6-8.)

This species is relegated to the genus *Orchestia* by the Rev. T. T. Stebbing (Ann. & Mag. of Nat. Hist., Oct. 1891, p. 325) —"Since both the figure and the description show that the first gnathopod in the female is not simple, but sub-chelate, that is to say, it has the precise character which separates *Orchestia* from *Talorchestia*." Unfortunately the figures which accompany Haswell's original description (in Proc. Linn. Soc. N.S.W., vol. iv., pl. vii., fig. 6) are too imperfect to be of any value for reference, while the description of the female gnathopod (l.c. p. 248) is by no means clear, and may easily stand the interpretation put on it by Mr. Stebbing. In specimens examined by me, the first gnathopod in the female is simply unguiculate (fig. 6) while the second (figs. 7 and 8) is imperfectly sub-chelate. There is no doubt, therefore, that Prof. Haswell is correct in his identification of this species as a *Talorchestia*.

The species is apparently abundant on the beaches between tide-marks, as I have numerous specimens taken from the undersides of stones in the Derwent and Huon estuaries, and from Pirates Bay. I have also one large female specimen, caught in a rock-pool at Pirates Bay, which looks different in general appearance, but appears in details of structure to assimilate so closely to this species that I am unable to separate it. It is fully half an inch long, and has the whole anterior part of the body more tumid than my other specimens. The New Zealand *Talorchestia quoyana* and *T. tumida* are species which cannot bear immersion in water, as they drown in a short time. This Tasmanian species appears to resemble littoral species of orchestia in this respect.

17. *Hyale rupicola.*

Allorchestes rupicola. Hasw. (Proc. Linn. Soc. N.S. Wales, vol. iv., p. 250, pl. viii., fig. 1.)

Specimens of this species were obtained by me from under stones between tide-marks in the neighbourhood of Hobart. They differ from specimens taken in Port Jackson, and kindly sent me by Prof. Haswell, in having the inferior antennæ stouter and more densely fringed with setæ on the lower margin. Prof. Haswell has not described the differences in the sexes; his description of the gnathopoda applies to the male only.

In the females the first gnathopod very closely resembles the corresponding limb in the male, but is smaller. The second gnathopod is also very similar in general form, but is considerably larger than the limb anterior to it, and has a somewhat similar ciliated projection on the lower side of the carpus. The so-called marsupial plate is large, rounded in front, ending in an acute postero-inferior angle, and is finely fringed all round with cilia. The coxal plate of the same limb is nearly circular, and its margin is quite smooth.

This species has not hitherto been recorded from Tasmania.

Fam. *Lysianassidæ*

18. *Lysianax stebbingi* * n. sp. (Pl. iii, figs., 9-18; Pl. v., figs. 9 and 10.)

The species is founded on a single specimen (a male) which was obtained in a rock-pool at Pirates Bay by Mr. R. M. Laing, and was handed to me by Mr. Chilton. The following is the specific character:—

Head, with a very minute rostrum, lateral lobes rounded; the back is smooth; eyes large, somewhat reniform, with very numerous ocelli; anterior antennæ stout, almost pyriform; peduncle longer than flagellum; second antennæ long and smooth; mandibles smooth at the apex, without cutting teeth; maxillipeds, with the outer plate, large, rounded and entire; dactylos of second pair of gnathopoda almost obsolete; last pair of uropods very short, inner ramus rudimentary.

The *first antennæ* (Pl. iii., fig. 10) are as long as the head and first segment of the thorax; the first joint is very stout, one-third the length of the whole appendage, and quite smooth; the second and third joints are shorter and less swollen, and together only about two-thirds as long as the basal joint; the second with a few setæ on the lower margin; flagellum, about ten-jointed, tapering to a very fine point, each joint bearing a few setæ; secondary appendage, about six-jointed, rather shorter than the principal flagellum.

The *second antennæ* are as long as the head and three anterior thoracic segments; the peduncle is short, and has the fifth joint bent, almost at right angles with the fourth, so that the rest of the limb is bent back along the side of the body; the flagellum is long and many (30-40) jointed, the joints are as broad as they are long, and are destitute of setæ.

The *mandibles* (fig. 11) end in a smooth point, and have about five minute blunt spines on the margin behind it; the molar tubercle is very feeble; the three-jointed palp is placed at a considerable distance from the apex of the limb; the second joint is the longest, and bears three small setæ near its extremity; the third joint is longer than the very short first one, and has about four small terminal setæ.

The *first maxillæ* (figs. 12 and 13) have the outer plate ending in about ten or eleven spines pectinately, toothed on the inner margin; palp very slender, ending in one long seta; inner plate short, ending in a minute seta.

The *second maxillæ* (fig 14) have the outer plate narrow, and ending in about ten very slender spines; inner plate, broader, with rather more spines, which are stouter and slightly shorter.

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* In compliment to the Rev. Thos. R. R. Stebbing, author of the Report on the Amphipoda of the "Challenger" Expedition.

The *maxillipeds* (fig. 15) have the basal plate elongated, notched at the apex, and finely setose on the margin; the outer plate is large, rounded, and has the margin perfectly entire, except below the middle of the inner side, where it bears two or three minute spines; the palp reaches a little beyond the outer plates, and has the joints finely setose.

The *first gnathopoda* (fig. 16) are simple and pediform; the side plates are large, and are produced anteriorly; the basos is straight; the ischium short, and the meros is sub-equal to it in length, and is produced on the lower setose margin into a conical projection; the carpus is rather longer, convex above, with tufts of setæ at the upper and lower extremities; propodos longer than carpus, tapering to the end, and with tufts of setæ on the lower margin; dactylos slightly curved, simple.

The *second gnathopoda* (figs. 17 and 18) are long and slender; the basos is long and narrow; the ischium about half as long, articulated almost at right angles to it, and with one terminal seta; the meros again is jointed almost at right angles to the ischium (so that the rest of the limb—in the dead specimens—is nearly parallel to the basos), and bears one long seta and a fringe of very minute hairs on its lower margin; the carpus is about as long as the ischium, is fringed with minute hairs on both surfaces, and bears two or three long setæ at the extremity of its upper and lower margins; the propodos is oval, broader than the carpus, but little more than half as long; it is fringed with very minute hairs on its lower margin, and on the upper half of its upper margin bears a number of long setæ; the dactylos is curved, and so small at to be almost undistinguishable even when magnified 150 diameters.

The *first pereiopoda* (Pl. v., fig. 9) have the side-plate nearly rectangular in form, and twice as deep as it is broad. In the *second* (Pl. v., fig. 10) the side-plate is the same depth, but the lower half is produced backwards as a rounded lobe, at right angles to, and twice as broad as, the upper half. The limb of the first pair is rather longer and more slender than that of the second; both are furnished with a few slender setæ on the lower side of the ischium, meros, and carpus. The *third pereiopoda* are somewhat shorter than the two anterior pairs; the side-plates are only about half as deep as those of the second pair, but are considerably broader than deep; the basos is posteriorly produced into a large rounded plate, while the meros is also produced into a broadened flange, which extends downwards at its apex, and ends in a seta; the front margin of the basal joints is furnished with simple setæ. In the *fourth* and *fifth* pairs the side-plates are successively smaller, and the plates on the basos larger than in the third; the margins also have short spines instead of setæ; the dactylos of the last pair is slender and nearly straight; in all the anterior pairs it is stronger and more curved. The *uropoda* decrease in length posteriorly, the last pair being very short; the outer branch of this pair ends in a stout terminal, and two short lateral spines, the inner is short and quite rudimentary; the telson appears to be cleft to the base, and each lobe to end in two small spines. Unfortunately my observation was made from the side, as I had mounted my only specimen as a permanent slide before I observed this detail from above.

Length, 6 mm. (about $\frac{1}{4}$ inch).

Colour, nearly white.

Integument, very hard and brittle, without any markings.

Fam. *Atylidæ.*

19. *Atyloides tasmaniæ.* Nov. sp. (Pl. ii., figs 9-15; Pl. iii., figs. 1 and 2.)

The specimens referred to this genus agree in nearly all respects with Stebbing's definition ("Challenger" Amphipoda, p. 913). In the first antennæ, however, I can discover no trace of the small accessory flagellum; but this is such a small organ, that, except in dissected specimens, it would be easily overlooked. The first maxillæ, also, have only about six setæ on the inner plate, in this respect resembling Stebbing's genus, *Atylopsis*, from which, however, it differs in not having the upper lip bilobed.

The body is compressed, perfectly smooth (minutely rugose under a high power), and not in any way carinated dorsally. The front of the cephalon is hardly produced between the rather large subquadrate eyes.

The *first antennæ* (fig. 9) are about half as long as the body; the joints of the peduncle are short and broad, diminishing in size distally, and are densely tufted on the ends of the lower margin with setæ; the flagellum is nearly twice as long as the peduncle; the joints are broader than long, and at intervals of half a dozen or more (fewer at the proximal end) occurs a broader joint tufted with the auditory (?) setæ so characteristic of this and allied genera. In one dissected specimen the flagellum had about forty articulations.

The *second antennæ* (fig. 10) are sub-equal in length with those of the first pair; the second joint of the peduncle has a stout spine at its lower extremity, while the next three joints are sub-equal in length, and are tufted with numerous setæ on the end of the lower margin; the flagellum is between two and three times as long as the peduncle; the joints are very numerous, are broader than long, and about every second is tufted with minute setæ; the *upper lip* is rounded and not incised.

The *mandibles* (fig. 11) have seven slender spines serrated on the convex margin on the spine-row; the molar tubercle is large, and is crossed by about twenty lines of serrations; its inner edge is defined by a tuft of small spines; the palp (fig. 12) has the second and third joints sub-equal in length; the basal joint is broadened distally, and has numerous strong spines on its inner margin; the second joint is fringed with two rows of setæ, especially towards the distal end, thus forming a kind of sheath, into which the somewhat falcate third joint can be bent; the last joint is setose on the inner margin, and ends in about nine spines, of which the inner four are pectinate.

The *first maxillæ* (fig. 13) have the inner plates small and furnished at the extremity with *six* plumose setæ; outer plates, with about ten stout spines, more or less toothed on their inner margins; outer joint of palp fringed with about ten toothed spines, and a corresponding number of short, simple setæ.

Second maxillæ (fig. 14) having the inner plate fringed with about fifteen plumose setæ on the inner margin—both plates ending in fine setæ.

The *maxillipeds* (fig. 15) have the inner plates narrow, and reaching considerably beyond the extremity of the first joint of the palp, densely fringed with curved setæ, which hide the three short teeth at the apex; outer plates almost reaching the end of the second joint of the palp, also densely fringed round the ends and inner margins with spines and plumose setæ; palp densely setose.

First gnathopoda (Pl. iii., fig. 1) with the coxal plates rounded and very short; basos with numerous setæ near the base on the lower margin and at the distal end; the short ischium and meros are also thickly furnished with setæ; the carpus is nearly smooth on the upper margin, while the lower is considerably rounded, and is densely fringed on the edge and on both sides; the propodos is broader than the carpus, the distal half of the lower margin forming the oblique palm, which is defined by a group of three or four strong, straight spines on each side; the whole joint is furnished with tufts of short setæ on the upper, and numerous rows of long setæ on the lower margin, sides, and end; dactylos, slender and curved.

Second gnathopoda, somewhat similar to the first pair, and sub-equal in size with coxal plates, short and rounded; gill, large, not reaching to the meros; basos, long, straight, and with very few spines on the margins; ischium and meros short, the latter densely setose on its distal half; carpus nearly triangular, with its lower margin produced downwards and thickly setose; propodos, tapering distally, the palm defined by a group of four pairs of stout spines, the whole joint densely setose; dactylos, stout, minutely setose on the inner margin.

Pereiopoda, increasing in length posteriorly. Second pair with coxal plates broadened and rounded behind; third pair with coxal plate short, two-lobed, front lobe rounded, hind lobe produced somewhat downwards, and bearing three spines; fourth and fifth pairs with the coxal plate developed only as a posterior lobe; basal plates extended widely.

Pleopoda, with the peduncles smooth, their extremity produced—in some pairs at least—into a curved process beside the base of the outer ramus.

Uropoda (Pl. iii., fig. 2)—First pair with a long peduncle and short rami; second pair with peduncle not reaching to extremity of that of the preceding pair, rami sub-equal; both pairs furnished with a row of marginal spines on the peduncle, and three or four on the rami; Peduncles of the third pair much shorter than the telson; rami, sub-equal in length, broadly lanceolate in form and tapering to a very acute apex, fringed on both margins with numerous spines, each carrying a long plumose seta in its axil.

Telson, long, reaching as far as the extremity of the second pair of uropoda, cleft beyond the centre, the lobes slightly tapering and rounded at the ends, margins quite destitute of spines or setæ.

Length of the largest specimen, 7 mm. (about $\frac{5}{16}$th of an inch).

This species was found in rock-pools at Pirates Bay.

This species may belong to Boeck's genus, *Pontogeneia*, but differs in having the third joint of the mandible-palp nearly as long as the second, and in wanting the accessory one-jointed appendage to the first antennæ.

On the other hand, Stebbing defines *Atyloides* as having "spine-teeth (not slender spines) on the inner margin of the outer plate of the maxillipeds." In the present species the inner margin has slender spines and no teeth. The distinctions between the two genera seem to me altogether too slight.

Fam. *Gammaridæ.*

Genus Niphargus, Schiödte.

This genus was instituted in 1851, for the reception of an eyeless Amphipod, found in the subterranean waters of various parts of Europe. Spence Bate, in the British Museum Catalogue, gives us one of the characters of the genus "eyes minute," and describes four species, all subterranean. Czerniavski, in 1868, added a species from the Black Sea, with "oval, fairly large eyes," while Grimm obtained another, a blind species, in the Caspian, at depths of 35-90 fathoms.

Among the Crustacea examined by me in the present collection are two fresh-water species, which I think must be placed in this genus, though they are somewhat different in appearance, and diverge somewhat from the generic character ot *Niphargus*, as defined by Spence Bate. On the other hand, neither is sufficiently distinct to justify the institution of a new genus for its reception, especially as the classification of the whole group is in want of revision. I accordingly place these forms here, pointing out under each species the features in which they differ from the generic character.

20. *Nipharyus mortoni,** n. sp. (Pl. iv., figs. 11 and 12 ; Pl. v., figs. 1-5)

The specimens described here were first found by me in a small stream above Franklin, on the Huon River, at an elevation of 200 to 300 feet above tide-marks The stream at the time of my visit was a minute runnel of water, which had cut a subterranean channel in many parts, and only here and there showed itself above ground. The little Crustacea were somewhat difficult of capture. They were mostly found creeping about under the little stones and bits of wood in the stream ; but, as soon as their hiding-places were disturbed, they abandoned themselves to the current, and were swept at once into darkness.

About the same time Mr. Laing, of Christchurch, N.Z., obtained one specimen (handed to me by my friend, Mr. Chilton) from the under side of a stone in a stream near The Springs, Mt. Wellington, that is is at an elevation of some 2000ft. More recently I have received a considerable number of specimens from Mr. Morton, who obtained them from the same locality. These were found clinging to the undersides of stones, pieces of wood, etc. There is some slight diversity amongst the different specimens from Franklin and Mt. Wellington, chiefly, however, in the relative number of hairs, setæ, etc., occurring on the different organs. Such variations are probably only individual or sexual.

The gnathopoda in this species, have not the propoda as broad as is usual in the genus. This, however, is not a feature of such importance as the fact that the telson is cleft into two distinct divisions, while in *Niphargus* it is a single telson, though deeply cleft. This, along with various other characters, induced me at first to place the species in the genus *Melita*, to which it approximates in many respects. But the latter genus is characterised *inter alia* by the great diversity of the gnathopoda in the two sexes, a feature which is quite wanting in the present form. The following are the specific characters :—

Body (Pl. v., fig. 5) greatly compressed; Coxæ of four

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*In honour of Mr. Alex. Morton, F.L.S., Secretary of the Royal Society of Tasmania.

anterior thoracic segments, as deep as the segments themselves, the three posterior not half as deep; fourth much wider than those in front of it; eyes small, oblong, close to the front margin of the cephalon; upper antennæ with joints of the peduncle sub-equal; lower, with the peduncle slightly shorter than that of the upper pair; maxillipeds, stout, with 4-jointed palp; both pairs of gnathopoda sub-equal, much compressed; terminal uropoda longer than the preceding pairs, inner branch almost obsolete; telson cleft into two portions.

The length of the largest specimen was $\frac{9}{10}$ inch (14mm.) The integument is generally smooth, but with a few minute hairs on the back and sides of the abdominal segments. The margins of the segments are also nearly quite smooth.

The *upper antennæ* were, in both instances, about two-thirds as long as the whole body; the joints of the peduncle were sub-equal in length, the middle one being slightly the longest; the flagellum, in most instances, was about twice as long as the base, but in one example it was quite short. This may, or may not, be a sexual difference; I could detect no other distinction in the animal. The secondary appendage was very small and 3-jointed.

In the *lower antennæ* the peduncle was rather shorter than the corresponding part in the superior pair; the fifth joint was rather shorter than the elongated fourth; the flagellum was composed of only some dozen joints, which were almost quite destitute of setæ, while those of the superior pair had only a few minute ones at the extremities.

The *mandible* palp (Pl. iv., fig. 11), which is three-jointed, has the basal joint, as usual, very short; the second is the longest, and has its lower margins broadened, flattened, and fringed in their proximal part. This seems to form a kind of sheath or hollow, into which the somewhat long terminal joint, which is beautifully setose along its lower margin, can apparently be folded.

The *first maxillæ* (Pl. iv., fig. 12) have the outer plate ending in about ten strong spines, the inner ones pectinately toothed on the inside; the inner plate is small, and carries four weak plumose setæ near its extremity; the palp is flattened, and placed nearly at right angles to the rest of the limb, its elongated second joint ends in a row of short spines.

The *second maxillæ* have the outer plate carrying numerous setæ at the extremity, while the smaller inner plate is fringed along the whole inner border.

The *maxillipeds* (Pl. v., fig. 2) are stout; the plates on the first joint are long, oval, and thickly fringed with setæ at the end; the plates on the second joint are larger, more rounded, and thickly setose on their inner sides; the palp is strong and four-jointed, with numerous setæ on the inside and extremities;

the claw, or fourth joint, is really two-jointed near its sharp apex.

The *first* and *second pairs of gnathopoda* (Pl. v., fig. 2) are sub-equal in size and form, and though distinctly sub-chelate are not very large; they have the basos long; the ischium and meros very short—the latter produced at its extremity into an acute point; the carpus broadening distally, with several tufts of setæ along its lower margin; the propodos sub-quadrate, with the palm obliquely transverse, and defined by a stout spine; dactylos, long, and slightly curved. Both pairs of limbs have the joints much compressed, and the propoda fringed with tufts of setæ, especially along their lower margins.

The *pereiopoda* increase in length posteriorly, are rather slender, with narrow basa, and have very short spinous setæ, which are only sparingly produced at the extremities of the joints.

The *uropoda* (Pl. v., fig 3) of the first and second pair, are sub-equal in length, and shorter than the outer branch of the third pair, which is very long, while the inner branch is so short as to be only seen with difficulty.

The *telson* (Pl. v., fig. 4) is cleft into two irregularly triangular portions, each tipped with a few spines; the number of the latter varying in different specimens.

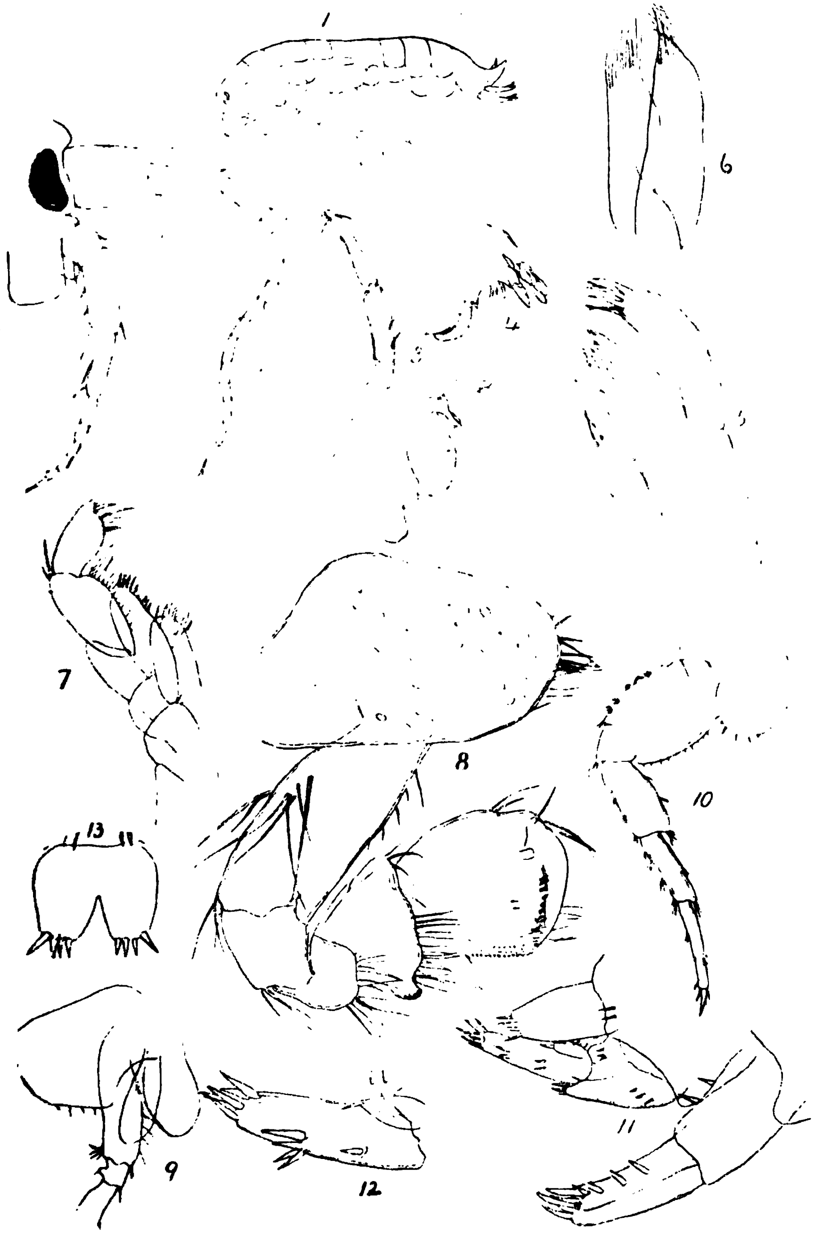
21. *Niphargus montanus*, n. sp. (Pl. vi., figs. 1-13.)

My first specimens of this interesting form were handed me by Mr. L. Rodway, who obtained them on the top of Mt. Wellington (4000ft). He had collected a bunch of sedges from some swampy ground near the summit, and on washing out the roots in a basin of water, observed a number of small amphipods swimming about; these he secured and handed to me. During this last winter, Mr. Morton made the ascent of the mountain, and obtained a considerable number of specimens from the pools, which were frozen over at the time.

The chief point in which this species differs from the generic character, is in the length of the last pair of uropods. These are hardly longer than those of the preceding pair; but, with this exception, it coincides very well with Spence Bate's definition. The following are the specific characters:—

Coxæ of four anterior segments produced considerably downwards, the posterior pairs only about half as deep; eyes, relatively large, subreniform, close to the rounded front margin of the cephalon; antennæ, short, superior pair not longer than the cephalon, and two anterior thoracic segments; lower pair with the joints of the peduncle sub-equal, and flagellum short; Maxillipeds, stout, with 4-jointed palp; both pairs of the gnathopoda sub-equal, with broad carpi and nearly square propoda; pereiopoda and uropoda furnished with short, very stout marginal spines; terminal uropoda, hardly longer than

Pl. VI



the preceding pairs, inner branch minute; telson cleft half-way to the base.

Length of largest specimens 6 mm. (about $\frac{1}{4}$ inch.) The colour varies from whitish-yellowish to brown, probably, according to the vegetation of the pools in which they occur. The integument is quite smooth.

The *first antennæ* (fig. 2) are about as long as the cephalon and two anterior segments of thorax; the first joint of the peduncle is stout; the second shorter and more slender; the third half as long, and not half as stout as the first; the flagellum is few (about 14-) jointed, and is somewhat longer than the peduncle; the secondary flagellum is very short and two-jointed.

The *second antennæ* are about half as long as the first; the peduncle only shows two joints, which are about two-thirds as long as the peduncle of the first pair; flagellum, about eight-jointed, shorter than peduncle; both pairs of antennæ have very few short hairs on them.

The mandible-palp (figs. 3 and 4) is three-jointed; the second joint has only a few short setæ on it; the third, which is subequal with it in length, is sparingly fringed with setæ on its lower margin and extremity.

The first maxillæ (fig. 5) end in six stout spines, which are all, more or less, pectinately toothed on the inner edge; the palp is stout, two-jointed, and ends in five short spines; the inner plate is rounded at the end and bears two slender terminal setæ.

The second maxillæ (fig. 6) are very thin and foliaceous, each plate ending in a number of slender setæ.

The maxillipeds (fig 7) have the plates on the first joint short, rounded, and bearing four blunt teeth and numerous setæ at the extremity; the plates on the second joint are also rather short and rounded; the inner edge at the extremity carries five short, blunt teeth, outside of which are five rather long and stout spines; the four-jointed palp has numerous setæ on its inner margin, while its third joint bears a small rounded tubercle.

The gnathopoda (fig. 8) are sub-equal in size and form in both sexes; the side-plates are deeper than broad, are evenly rounded, and carry a few fine setæ on the lower margin; the straight basos has a few long, slender setæ on the posterior margin; the meros is short; the ischium still shorter, and fringed with setæ on its distal margin; the carpus broadly triangular, and carrying a few setæ along its lower edge; the propodos is nearly square, its upper edge is slightly rounded, and bears a few cilia; the lower edge is rugose; the transverse palm is fringed with minute teeth, and ends in two or three stout spines.

The pereiopoda (figs. 9 and 10) increase slightly in length to the fourth, which is the longest, the fifth being rather shorter; all the joints are furnished with clusters of short, acute spines; the side-plate of the first pair resembles those of the gnathopods; that of the second pair is broad and excavate in front; the third is two-lobed, the posterior lobe being the largest and having five or six short marginal spines.

The first and second uropods (fig. 11) reach almost as far back as the extremity of the third pair; the last has the outer branch well developed, but shorter than is usual in the genus; the inner branch (fig. 12) is represented by a minute lobe tipped with a single seta; the telson (fig. 13) is cleft half-way to the base, each division ending in four short spines.

22. *Mæra fasciculata*, mihi.

Megœmera fasciculata, mihi (Ann. and Mag. of Nat. Hist. Ser. 5, vol. vi., p. 5, pl. i., fig. 5.)

Some small specimens of this species were collected by Mr. R. M. Laing in shallow pools between tide-marks on the Huon river. They agree very closely with specimens from New Zealand.

This species agrees with Boeck's definition of *Mæra*, except in regard to the second gnathopoda, which have *not* the hand "much larger than in the first pair." It is somewhat larger, but not more than half as long again, the breadth in both being about the same.

The species has been found abundantly on the east coast of New Zealand (South Island) by both Mr. Chilton and myself.

Addendum.

In Budde-Lund's Crustacea Isopoda Terrestria, p. 285, a species of *Armadillo* is described from Tasmania, unfortunately, without figures. I append here a translation of his description. The species belongs to the section of the genus, characterised by him as follows:—

"External terminal rami of the anal feet obliquely tetragonal (trapezoidal), usually much smaller and shorter than the basal articulation, rarely equal in size; epimera of the first segment of the body simple, slender; anal segment of the abdomen triangular, with the apex more or less acute."

Armadillo misellus.

Oblong-oval, very convex, opaque (?); body everywhere distinctly tubercled; the whole surface minutely pubescent.

External antennæ rather shorter than half the body; flagellum 5-articulate, shorter than the peduncle; first articulation of the flagellum rather shorter than the next three.

Clypeus, with shorter lobes, sub-triangular, epistome somewhat convex, with the superior margin not reaching beyond the front.

First segment of the body with the lateral margin thickened, slightly revolute, somewhat furrowed longitudinally, subequally cleft behind; epimera of the second segment cleft, interior part short, toothed; posterior margin of the first three segments slightly sinuate on both sides.

Anal segment of the abdomen not broader than long, contracted in the middle, posterior margin nearly straight, with the external angles rounded, nearly straight (?); basal articulation a little longer than broad, external branch shortest, inserted above the broader internal; internal branch somewhat shorter than the anal segment.

Colour, greyish.

Length, 8 mm.; breadth, 3·75 mm.; height, 2 mm.

The specimen described, which was taken in Tasmania by Dr. Scheyer, is presented in the Berlin Museum.

A somewhat allied species (*A. vulgare*) is described by Budde-Lund as having been collected at Melbourne.

EXPLANATION OF FIGURES.

PLATE I.

Figs. 1 & 2. Engæus cunicularius.
  1. Female, nat. size. (The abdomen is too broad in the figure.)
  2. Rostrum (mag.)

Figs. 3-5. Gebia simsoni.
  3. Animal, nat. size.
  4. Rostrum, from above x3.
  5. Telson and uropods spread out, x2.

Figs. 6-13. Oniscus punctatus.
  6. First antenna, x40.
  7. Second antenna x10
  8. Right and left mandibles, x56.
  9. First maxilla, x56.
  10. Second maxilla, x56.
  11. Maxillipeds, x40.
  12. Extremity of abdomen from below (*an*-anus) x19.
  13. Uropod, x26.

PLATE II.

Figs. 1 to 8. Actœcia euchroa.

1. Outline of animal, x10.
2. Same from above, x10.
3. First antenna, x56.
4. Second antenna, x40.
5. Mandible, x56.
6. First maxilla, x56.
7. Maxillipeds, x56.
8. Last segment of abdomen and uropods, x40.

Figs. 9-15. Atyloides tasmaniæ.

9. First antenna, x40.
10. Second antenna, x40.
11. Mandibles, x56.
12. do. palp, x56.
13. First maxilla, x56.
14. Second maxilla, x56.
15. Maxilliped, x40.

PLATE III.

Figs. 1 & 2. Atyloides tasmaniæ.

1. First gnathopod, x26.
2. Telson and last pair of uropoda, x26.

Figs. 3-8. Rocinela spongicola.

3. Animal, dorsal view, x3.
4. Mandible, x26.
5. Extremity of mandible, x56.
6. First maxilla, x41.
7. Second maxilla, x41.
8. Maxilliped, x41.

Figs. 9-18. Lysianax stebbingi.

9. Outline of body, x9.
10. First antenna, x41.
11. Mandible, x41.
12. First maxilla, x41.
13. Extremity of same, x184.
14. Second maxilla, x41.
15. Maxilliped, x41.
16. End of first gnathopod, x41.
17. Second gnathopod, x41.
18. Hand of second gnathopod, x125.

PLATE IV.

Figs. 1-10. Talitrus sylvaticus.

1. Mandible, x56.
2. Lower lip, x84.
3. Maxillæ (*a*) first pair; (*b*) second pair, x56.
4. Maxillipeds, x56.
5. Second gnathopod of male (Sydney specimen), x13.
6. do. do. do. (Mt. Wellington specimen), x13.
7. Fifth pereiopod, x40.
8. Pleopod of first pair, x40.
9. Telson, x56.
10. Last pair of uropoda, x56.

Figs. 11 & 12. Niphargus mortoni.

11. Mandible-palp, x40.
12. First maxilla, x40.

PLATE V.

Figs. 1-5. Niphargus mortoni.

1. Maxillipeds, x40.
2. Second gnathopod, x26.
3. Extremity of abdomen from the side, x17.
4. Telson (*t*), with inner branch of last uropod] (*u*) from above, x28.
5. Outline of body (of female), x5.

Figs. 6-8 Talorchestia diemenensis (female.)

6. First gnathopod, x26.
7. Second gnathopod, x26.
8. Hand of second gnathopod, x56.

Figs. 9 & 10. Lysianax stebbingi.

9. First pereiopod, x26.
10. Second pereiopod, x26.

PLATE VI.

Figs. 1-13. Niphargus montanus.

1. Animal, x7.
2. Front of head and antennæ, x41.

Figs. 3 & 4. Mandibles, x56.

5. First maxilla, x125.
6. Second maxilla, x125.
7. Maxilliped, x56.
8. First gnathopod, x56.
9. Second pereiopod, x26.
10. Third do. x26.
11. Two last uropods and telson, x56.
12. Last uropod, showing the inner branch (i.b.), x125.
13. Telson, from above, x56.

Phreatoicus australis. Chilton.

Post Scriptum.

In putting aside my specimens, described in this paper, I found in the tube containing *Niphargus montanus*, collected by Mr. Rodway, a single immature specimen of the remarkable Isopod, *Phreatoicus australis.* The specimen was only about 4 mm. (a little over $\frac{1}{6}$ inch) in length. The occurrence of this species adds another to the singular group of forms found in the pools on the top of Mt. Wellington. The genus was established in 1882 by Mr. C. Chilton, for the reception of a blind subterranean Isopod—*P. typicus*—which occurs in wells in Canterbury, New Zealand. In 1889, Mr. Chilton received a small collection of Australian Crustacea, and this included a new species of *Phreatoicus* (*P. australis*) from Mt. Kosciusko, at a height of 5,700 feet.

I have already pointed out that the characters of *Anaspis*, possessing, as it does, an extremely generalised structure, lead to the conclusion that it is of great antiquity. The same evidence is borne by the occurrence of *Niphargus montanus.*

The evidence of the antique character of this fresh-water fauna is still further strengthened by *Phreatoicus.* The distribution of the genus is, in the first place, remarkable, one blind species occurring in New Zealand, and another possessing well-developed eyes, in two such widely separated localities as Mt. Wellington (4,100ft.), in Tasmania, and Mt. Kosciusko (5,700ft.), in south-eastern Australia. And, again, *Phreatoicus* is a highly generalised Isopod, resembling the *Asellidæ* perhaps more than any other family, but sufficiently distinct to be separated as the type of a new family, the *Phreatoicidæ.*

Probably an examination of other streams and pools at high elevations in Tasmania and Australia will reveal further examples of this interesting archaic fresh-water fauna.

NOTE ON A TASMANIAN "ACANTHIZA"

(BUSH TIT).

[BY COLONEL W. V. LEGGE, F.Z.S., late F.L.S.].

Gould has figured in his work three species of Acanthizas from Tasmania, viz: the two common and well-known birds, *Acanthiza chrysorrhœa,* and *A. diemenensis*—the "Yellow tail" and "Brown tail"—and a third, *A. ewingi,* Ewing's Acanthiza. This latter species, figured on Plate 35, vol. iii., B. of Australia, is stated to differ from *A. diemenensis* in being a slenderer bird, with a proportionately longer tarsus, and in having a rufous band on the wing, formed by the basal portion of the outer ribs of the primary feathers. It has, however, been expunged from modern treatises on Australian Avifauna, for Mr. Sharpe, in his "Catalogue of Birds," vol. vii., p. 295, unites it with *A. diemenensis,* and Dr. Ramsay has omitted it from his "List of Australian Birds." That there are, however, two species of "Brown tail" in this island is, I am of opinion, tolerably certain, but being closely allied and a sufficient series for comparison not being extant in the national collection at the British Museum, Mr. Sharpe failed to recognise their distinctness. For many years past but little attention has been paid to the smaller species of Tasmanian birds, and comparatively little scientific work done among them. There is, unfortunately, no carefully formed collection of Tasmanian birds in the skin existing in the colony, and very few field notes have been made on the smaller species of forest birds, save in the direction of oology. The consequence is that such points as the specific distinctness, or otherwise, of two little noticed species like these in question is more than likely to have been passed over.

Last December, when visiting an out-of-the-way settlement on the Elephant Hill, near St. Mary's, situated about 1,500 feet above sea level, I met with a solitary bird hopping about the scrub and bushes, on the edge of a clearing, and being attracted by its peculiar note, I procured it, having by chance my gun with me. It proved to be a small Acanthiza, very similar to the common "Brown tail," or Tasmanian Acanthiza, but differing in having the forehead pale rufescent grey, instead of rufous, and the throat and foreneck with the markings much less pronounced than in the last-named species; in fact the colouration of that part is almost uniform, the centres of the feathers being also slightly darker than the rest of the web. At the base of the outer webs of the primaries there is a narrow rufous band, similar to that shown in Gould's figure, which, however, has the markings of the throat more pronounced than in my specimen, owing to the absence of throat markings. I was inclined to look on the bird as an immature male of the common Brown Tail, particularly as the month was that in which so many young birds are procurable, but the actions and note of this individual were so totally different from that of the Tasmanian Acanthiza that no doubt is left in my mind as to its distinctness. The common species is gregarious, nearly always being found in little parties, which flit about with great zest and activity, uttering in unison their peculiar little note, which may be syllobised, *zit, zit, zit, whoorl,* the latter being somewhat gutteral. The note of my new species resembles, *tit, tit, too, woo,* the latter syllables being soft and melodious.

The dimensions of this example were as follow:—

Length, 4·0 inches; wing, from carpal joint, 1·9; tail, 1·9; tonces, 0·75; bill, to gape, 0·45. Iris light red (paler than in the common species); bill, brown, slaty at the base; legs and feet dark olive brown. The contents of the stomach were small ants and minute coleoptera, mixed with some curious globular masses, resembling hard seeds. There can be little doubt that this bird is, in reality, the *Acanthiza ewingi* of Gould; which should, therefore, be reinstated in the Tasmanian avifauna.

NOTE ON THE VORACITY OF THE KELP FISH.

While fishing for crayfish recently, on the East Coast, I caught a couple of so-called "Kelpfish" in the net. This fish, belonging to the family *Labridæ,* is a favorite bait with fishermen for the crayfish caught in hand nets, and is found in moderately shallow water, sometimes, and at others in deep pools, but always in beds of kelp. On opening the individuals I caught I was surprised to find their stomachs full of the small white, conical, and calcareous shells which cover the tops and sides of rocks, which are covered at high water; but among these were also moderately large limpet shells swallowed whole, the fish, in some instances, being still attached to the shell. Enclosed are some of these shells from the stomach of one of the fish, which was about 1¼lb. in weight. I examined its strong, circular teeth, and found one tooth gone at the point of each jaw, evidently wrenched out by the force of grasping such a strongly attached shell-fish as the limpet. But great as the strength required to detach a limpet, it must be nothing to the grinding, gnawing motion required to tear off the small, scarcely protuberant calcareous shells first mentioned, and with which the stomachs were pretty well filled.

It is a singular trait in the economy of this fish, which leads it to subsist on such an apparently unappetising mass as had formed the meal of these examples just prior to my catching them.

ON THE OCCURRENCE OF SOME AUSTRALIAN *ARDEIDÆ* IN TASMANIA.

The past summer and autumn have been marked by a special visitation of two species of Australian Herons to Tasmania. One, the White Egret, *Herodias alba*, Linn., which has hitherto been an occasional straggler to the island, has occurred in considerable numbers during the summer, both in the north and south. The other, *Ardea pacifica*, Latham, a rare visitant to Tasmania, has been half a dozen times met with in the north during the past two months.

The localities visited by the White Egret appear to have been the basin of the Derwent, including the Sorell district, the Midlands, and the vicinity of the Tamar and Esk rivers in the north. Mr. T. Carr, a prominent member of the Northern Science Association, informs me that he has had numerous examples brought to him, which has also been the case as regards the Hobart Museum, which testify, unfortunately, to the old story in England: that as soon as a new bird appears on the landscape, it is shot down by every pot-hunter who meets with it. More of these handsome white visitors have doubtless been immature birds, which might have remained in the island, and, in any case, would have returned another year; their destruction, therefore, means the partial driving away of an interesting, permanent addition to our avifauna. This species is so widely distributed that there is no reason why it should not become a resident in the island, breeding at the more retired lagoons and morasses of the lake district. It may not be out of place to glance here at the geographical distribution of the White Egret. The union of the Australian form, *Herodias syrmatophorus* of Gould, with the widely-distributed *Herodias alba* of Linnæus, very widely extends the range of the species under consideration. The former was separated by Gould from the old world species on account of its small size, and for a like reason, the bird commonly found throughout India was given specific rank by that herculean worker in Indian ornithology, Mr. Allen Hume, C.B., the editor of the now defunct "Stray Feathers." An examination, however, of a large series got together from various parts of the world, such as that in the national collection at the British Museum, shows that the Indian, Chinese, and Australian and, perhaps, the African representatives of the species are all, more or less, diminutive in size, while the larger race inhabits Central Asia, Russia, the Delta of the Nile, and Syria. Examples in the British Museum, from Kashgaria, Russia, and Egypt, measured by me, gave a length in the wing of 17·6, 16·5, and 16·3 inches respectively, while a specimen of the larger race, often met with in India (and probably straying south from Kashgaria), reached a length of of 17·0 inches in the wing. On the other hand, North African, Chinese, and Australian specimens measured in the wing, 14·7 to 15·5; 14·2 to 14·75, and 13·0 inches respectively. Ceylonese examples, again, give a length of 13·5 to 15·0 inches. There is, in fact, a regular gradation from the Australian, Chinese, and Indian races to the birds inhabiting the cooler districts above-mentioned, the large examples found occasionally in tropical localities being either local birds, abnormal in size, or wanderers from contiguous cool countries. As regards Tasmanian examples, the measurements of the wing, supplied to me by Mr. Carr, are 13·75 to 14·0 inches, which correspond wtih those of the smaller races noticed above.

The White Egret ranges from South Africa, along both coasts of the continent to the North, bordering on the Delta of the Nile. It is tolerably common in Russia, and Central and Southern Europe, breeding in the great marshes of Hungary. In France and Spain, however, it is rare, and appears to be absent from Portugal, though found farther west in the Azores. To Great Britain it is a straggler. Coming now to Asia, we find it common in Asia Minor, and occurring in Persia, whence it ranges through Central and Highland Asia, and along the great Chinese rivers to the coast, and thence to the island of Formosa, where Swinhoe procured it. Southwards it extends into India, Ceylon, and the islands of the Bay of Bengal, passing down the Malay Peninsula, and ranging through the islands of Malayana to Australia. In the latter continent it appears in Dr. Ramsay's "Distribution List," as very widely scattered round the coasts of all the colonies, and it extends inland to Riverina, though this author does not record it from the far interior.

The second species under notice, *Ardea pacifica*, Latham, appears to have visited the island in a small flock during the autumn, and then spread over the northern districts. Mr. Carr informs me that it was recently shot at the Lake River, on the Tamar, and at Stanley, within the space of a day or two. On the 24th ult. I procured an adult female on my own estate at Cullenswood. It was frequenting some temporary rain pools in a paddock not far from the house, and was very shy, but by stalking it in long grass I managed to get a shot and procured it.

The Pacific Heron is a handsome species, with great expanse of wing for the size of its body, which gives it a heavy, flopping flight. The measurements and description of my specimens are as follow:—Length, 30·0 inches; wing, 15·75; tail, 5·25; tarsus, 5·0; middle toe, 2·75; bill, tip to gape, 4·4. It is mottled greenish slate; orbitar skin, dusky bluish; upper mandible and sides of lower, black; base beneath, fleshy whitish; legs and feet, black.

Back wings and tail, dark green, glossed on the outer webs, and tinged with ashy on the shorter scapular feathers; the inner webs of the longer scapular, and a longitudinal patch on each side of the chest, maroon; head, entire neck and throat, white; marked everywhere, but on the chin and throat with cinereous grey; down the centre of the foreneck a stripe of interupted black spots; breast and under surface, dark slate; the feathers with a broad, neesial white stripe, widest on the under tail coverts; a broad, white patch over the point of the wing, extending along the edge to the base of the outer primaries.

This Heron is distributed widely around the Australian Continent, being found on the extreme north coast, though not recorded from the opposite shores of New Guinea, while on the east and south coasts it is an inhabitant of each colony, likewise extending to Western Australia. Although an occasional visitor to Tasmania, so far as past observation shows, it may, perhaps, become more frequent if not molested on its summer visits to us. It is not at all uncommon in the swamps on the Murray and the plains of Riverina.

ADDITIONS TO TASMANIAN FLORA, II.

[By L. Rodway.]

Before the year closes I should like to place on record sundry additions to the known plants of Tasmania, found in the vicinity of George's Bay by Mr. Wm. Fitzgerald. They have been verified by Baron von Müeller.

Claytonia pygmæa, F. v. M. This plant is about the size and general habit of its near relation, the common Tasmanian C. calyptrata, from which it can be at once distinguished by its less elongated inflorescence and larger sepals. Subsequent to flowering the sepals close over the capsule, completely burying it between their thick, fleshy masses.

Hydrocotyle capillaris, F. v. M. As small and somewhat resembling H. tripartita (R. Br.), only the leaves are not so deeply divided; usually divided half way to the petiole into three entire lobes. The fruit is very distinct; the intermediate ribs are prominent, and the space between them and the dorsal rib is filled with a spongy-pitted formation.

Schœnus turbinatus, Poiret. This very distinct sedge has, up to the present, only been found in one or two situations, by Fitzgerald. Its occurrence in N.S. Wales led to the suspicion that it had been introduced, but its distance from cultivation, together with the subsequent discovery in the same district of Corysanthes bicalcarata and Schœnus brevifolius, both also natives of New South Wales, considerably raises its claim to be indigenous. The inflorescence of this plant differs from other Tasmanian members of the genus by being collected in tolerably dense beads. In general appearance it approaches Carpha alpina more than any other of our sedges.

Schœnus brevifolius, R. Br. A tall sedge, with almost the habit of a Restio, the specimens found by Fitzgerald often attaining 3ft. The inflorescence is in long, loose, interupted panicles, often 6 or 8in. long.

Gahnia fitzgeraldi. Plant densely cœspitose; stems numerous from a creeping rhizome, about 2ft. high, slender, terete; outer leaves reduced to scarious sheathing scales; inner ones as long as, or shorter than, the stem, with sharply involute margins, and long, subulate points, gradually passing into the bracts subtending the branches of the panicle; panicle 8in. to 12in. long, interrupted branches arising few together from distant bracts, unequal, usually elongated and erect, bearing the spikelets freely distant from one another, the whole panicle having a linear appearance, but sometimes they are short and contracted, the spikelets then forming small, distant, rather dense heads; spikelets numerous, dark-brown, about 1½ lines long, more or less pedicelled, each subtended by a narrow, aristate bract; outer empty glumes, about four, slightly scabrous on the margin and mid-rib, more or less mucronate, seldom having a much elongated point; flowers, two, the outer one male, the inner hermaphrodite, and an empty glume developed above the flower; stamens, usually three, but in vigorous male flowers, four; style branches, three; nut, about ¾ to 1 line long, ovoid-oblong, dark, not differing in any detail from the nut of G. trifida, and, like it, finely reticulated; filaments partially deciduous, not supporting the nut as in allied species, the bases only remaining.

This plant has a similar, though smaller, habit to Gahnia trifida, Lab., but it has a very dissimilar inflorescence, and distinctly differently constructed spikelets, that species bearing a solitary terminal hermaphrodite flower. I submitted the plant to Baron von Müeller, he considered it new to science, but was too busy at the time to give it the attention required. Subsequently, Mr. Fitzgerald had occasion to correspond with F. Turner, F.L.S., of Sydney, who was not disposed to consider it specifically distinct. Since that I have made an exhaustive examination of a great number of specimens, and, with Baron von Müeller's sanction, and under our joint authority, I have described it as above.

THE USE OF THE WOMERAH, OR "THROW STICK" BY THE ABORIGINES OF TASMANIA.

[BY ALFRED J. TAYLOR, F.L.S.]

In the course of a discussion that followed a lecture I delivered recently on the Aboriginies of Tasmania, Mr. Thomas Lewis, a member of this Society, referred to the use of the "Womerah," or "Throw Stick" by our natives. This was the first time I had heard of the instrument being used by the aborigines of Tasmania. There is no record of their use of it in any of the works dealing with their history, nor is the Womerah preserved in any of our Ethnological Collections of Tasmanian Weapons, etc. On the contrary, Ronald Gunn, F.R.S., informed Mr. R. Brough Smythe, who has duly recorded the statement in his account of the aborigines of Tasmania, that "they had no throwing sticks."

The fact related to me by Mr. Lewis, that the natives of this island used the Womerah; that they knew it by that name, and that he himself saw them using it when Robinson brought in the remnants of the race after the celebrated "black war," about the year 1835, is interesting in more ways than one.

It is interesting to know that it was used by our natives at all, and it is interesting to know that it was known by the same name as it is known by among the Goulburn tribe of natives in Victoria. The latter fact may help us in unravelling the mystery of the origin of our aborigines as a race—other tribes calling the instrument by a different name.

The Womerah used by the Victorian blacks is usually a mere stick, with a hook or projection at one end, which the hollow at the end of the spears used fits on to. The object of the Womerah is to give length to the natural arm, and so gain additional leverage power for casting the spear, which, by its aid, could be thrown more swiftly, and to a greater distance.

I was at first inclined to think that perhaps the natives of Tasmania had been taught the use of the Womerah by the native "Mosquito," who came over from New South Wales to Tasmania in the early days of the Colony; but Mr. Morton tells me that there is no hollow in the end of the spears he has in the Museum, showing that for such spears, at least, a Womerah, similar to that made by the natives of other tribes, had not been used.

This, however, presents no difficulty, as Mr. Lewis tells me that instead of having a hook at the end, the Womerah used by the natives of Tasmania had a projection at one end that was hollowed out, and into which hollow the end of the spear was fixed. Perhaps others who read these notes may be able to throw some light on the subject.

CONCERNING VARIOUS MEANS OF ENCOURAGING THE STUDY OF NATURAL HISTORY IN TASMANIA.

[By James R. McClymont, M.A.]

When consulting, recently, the British Museum Catalogue of Lizards, I found that about eighteen species or varieties were attributed to Tasmania, whereas only about five species are admitted by local authorities. This impressed on me the fact which I had previously seen stated, that our natural history collections are, in some respects, still very incomplete. Possibly some of the British Museum specimens of lizards are wrongly allocated, but, allowing for errors in this direction, it would still appear that the collection of Tasmanian lizards in London is more complete than any in Tasmania. However, I quote the instance as typical, not as exceptional. The same is true of the Mollusca. "Nearly half," says Mr. R. M. Johnston, "of the number of the principal type species (of shells) are deposited in foreign museums, and are therefore inaccessible for purposes of reference to local students" (R. S. Tas. Proc., 1890, p. 57).

I am afraid the dispersal of these specimens shows that very little patriotic interest is taken in this matter, and I purpose, briefly, to enquire how such an interest can be awakened and sustained. I shall deal with three only of the most evident means to this end.

(1) The establishment of district museums.

(2) The compilation of cheap scientific manuals, having special reference to the natural history of Tasmania.

(3) The establishment of a lectureship in biology in connection with the Tasmanian University.

(1) My idea of a district museum is a local depository of specimens of the fauna and flora of some well-defined geographical area, such as a group of islands, or a peninsula, or a portion of coast to a given distance inland, or a table-land, or a mountain chain. From a strictly scientific standpoint, such an area would be limited by the homogeneity of its flora or fauna, or by the individuality of its geological features. But as one object of local museums in a new country would be to discover such boundaries, not to ratify them; the definition of a museum area must, in the first instance, result from convenience and practicability.

If we had Field Naturalists Clubs in Tasmania there would be no difficulty about opening local museums. These clubs make it part of their work to form collections of natural objects, and we can imagine what healthy rivalry must be created between clubs in different districts, each striving to excel in the completeness and orderliness of its little local collection. But these clubs do not exist with us, although efforts have been made to establish them, and, though desirable, it is not absolutely necessary to have them before we can hope to open a few local museums, There are many amateur collections of shells, eggs, and other natural objects aimlessly and almost uselessly acquired and maintained; there are many lovers of natural history scattered through the country districts without any definite end in their studies, without specimens to throw life into their reading, without that cohesiveness and unity of purpose which co-operative collecting for a local museum would impart. To both these classes I appeal; to the former, to unselfishly contribute their unclassified private collections to form public and classified ones; to the latter to contribute their time and knowledge for the purpose of inaugurating and arranging collections for their district. I appeal to the well-to-do landowners of the colony for the necessary means. Those of them—possibly there are no exceptions—who are deeply interested in the spread of sound knowledge amongst the people, who are interested in the advance of the colony as a whole, who would joyfully see Tasmania stand up and *do* something—to those I appeal for aid to procure the necessary buildings and fittings. Many of them could spare a room or a renovated outbuilding; many of them could, at little cost, supply shelves or tables to be converted into cases for specimens; all of them could contribute their pence and their moral support.

But it is to the lovers of natural history in the country districts, who with that love combine a fair knowledge at least of the elements of some one branch of natural science, that I look in the first place for support. They would have to take the initiative in their own particular districts, to air the proposal, to interview the amateur collector and soften his heart, to enlist the sympathy of the all-powerful man of substance to set the whole machinery in motion.

At the outset the founders of the local museums would be encountered by serious difficulties in the matter of preserving specimens. Suppose a small building be provided and drawers or cases procured, how are the specimens to be preserved from decay, and from insect pests? As regards the herbarium, some useful directions are given by Mr. Spicer in his "Handbook of the Plants of Tasmania." I would urgently impress upon the Royal Society the utility of publishing directions for the preservation of skins, insects, and reptiles, and regarding the best method of capturing and killing insects. A leaflet would contain all that is necessary, and I am sure the Society would be amply repaid the trifling expense and trouble involved in the preparation of it by the addition to our scientific knowledge that would result therefrom. Let this be the Royal Society's contribution towards the project.

Local museums would educate in many ways, about which I will not expatiate, as I desire to be brief and pointed. Labels would have to be prepared similar to those in use in the Tasmanian museum; but for those who had time and inclination to pursue natural history studies there would have to be more advanced guides in the shape of hand-books to the various branches, compiled with special reference to Tasmania.

(2) There is but a small demand, at present, for such hand-books, but still there is a demand; local museums, I believe, would be the means of greatly increasing it. And I have the more confidence in proposing the hand-books, because somethings of the kind has been already adumbrated in respect of Birds by Col. Legge, Molluscs by Mr. Johnston, Ferns by Mr. Morton. These works, if not intended to assume exactly the form of hand-books, would at least be conducive to their preparation. In some departments, no doubt, our existing information is not complete enough to justify the dogmatism of a text-book. It would be much more complete if we had local collections open to our scientists for purposes of comparison; but there are other departments—those I have mentioned for example—in which we are advanced enough to speak with authority.

(3) Finally, as the cope-stone of the edifice, I would suggest a lectureship in biology in connection with the Tasmanian University. When one reflects that a brief three years ago a university was an unsuspected privilege, it may seem somewhat bold even to hint at a natural history chair in connection with it. I could, perhaps, point with some forcibleness to the example of other colonies; I could mention a Tate, a McCoy, a Hutton, and ask whether the advantages, which have accrued to South Australia, Victoria, and New Zealand from the labours of these indefatigable men of science, might not reasonably be expected to accrue to Tasmania from the labours of one of their compeers. But I refrain, being confronted with the inevitable question of the means thereto. Moreover, the Council of the University have, no doubt, their own ideas as to the fittest allocation of their funds, and the possibility of adding another lectureship to those already established. This much I may be permitted to hope, that they will duly consider the claims of biology to be represented on their teaching staff, and remember the fact that their energy and success in biological investigations have done as much as anything to establish the thoroughness, the originality, and the entire reasonableness of colonial universities in the eyes of the educated world.

ON THE CLASSIFICATORY POSITION AND SYNONYMS OF EATONIELLA RUFILABRIS.

[BY PROFESSOR RALPH TATE, F.L.S., F.G.S., COR. MEMB.]

The subject of this communication, which has long been known as *Bithynia*, or *Tatea huonensis*, though another specific name has priority of fourteen years, has hitherto been handed about from genus to genus without finding a resting place. For some years past I have been convinced of the incompatability of its reference to those families under which it has been placed; its location under Rissoininæ was the first step which led me to its present classificatory position in the genus *Eatoniella*.

The main portion of this essay was written twelve years ago, but the desire to fully work out the anatomical characters has always been my plea for postponement of publication; now, however, the opportunity of addressing the conchologists of Tasmania, who have most materially contributed to the bibliography of the species, cannot be resisted, though further study in the direction indicated is still very desirable.

The shell was first made known by A. Adams in 1862 (unless *Amnicola badia*, Gould, is the same) from specimens collected on the shore at Port Lincoln, in South Australia, and named by him, *Diala rufilabris*. E. A. Smith, in 1875, pointed out that it differed essentially from *Diala*, by its thickened and continuous peristome, and oblique aperture and columella, and removed it to the genus *Hydrobia*.

Tenison-Woods, in 1875, described the same shell as *Bythinia huonensis*. In 1878 R. M. Johnston transferred it to *Bithynella*, and Tenison-Woods in the same year, from information concerning the animal which I had supplied, did me the honour to erect for it the genus *Tatea*, which has done service till now. Unfortunately, Tenison-Woods mis-read my notes on the animal, and partially made amends in the following year; the chief error in his description relates to the operculum, which is not calcareous, though it is somewhat strengthened on the inner face with calcareous matter. In this way Tryon, 1883, came to be mislead, and placed *Tatea* in the family Rissoellidæ; this is repeated by the same author in 1887, and is followed by Fischer, in his "Manuel de Conch." of the same year.

In the meanwhile, E. A. Smith, in 1882, proved the identity of *Diala rufilabris* and *Tatea huonensis* by comparison of Adams' type with authentic examples from Tasmania, and quotes the species as *Tatea rufilabris*. Up to this time the shell had remained unfigured, and it has subsequently been illustrated by Tryon in 1887, and Petterd in 1889. No further information of the animal has been published than that given by Tenison-Woods at the two references under *Tatea huonensis.*

On the publication of the anatomical characters of the animal of *Dardania* (Hutton) a new genus of Rissoinæ, in Trans. New Zealand Institute, 1882, I could not fail to recognise in it a congener with *Tatea rufilabris.* Both Tryon and Fischer place *Dardania* and *Tatea* as subgenera under *Jeffreysia.* Further investigations by Hutton (Proc Lin. Soc., N.S. Wales, vol. ix., p. 940, 1885) have lead him to consider *Dardania* synonymic with *Eatonia* (E. A. Smith), changed by Dall to *Eatoniella,* because Smith's name was preoccupied. In all essential characters *Dardania olivacea* and *Tatea rufilabris* agree with *Eatoniella*; however, they are not of the same species, differing much in the shape of the shell, and in the outline of the foot.

My observations on the animal of Eatoniella rufilabris, are as follow:—*Foot,* when extended, between two and three times as long as broad, truncated and auricled in front, somewhat narrowed in the ante-medial region, expanded and rounded posteriorly; *muzzle,* reddish-brown, with a colourless tip; *tentacles,* long, subulate, colourless, but encircled with brown near the tips; *operculum,* pancisperal, thick, externally corneous, somewhat calcareous on inner face, provided with a vertical submarginal claw, which is denticulated on its edge. The animal resembles that of *Amnicola,* as represented by Stimpson ("Researches upon the *Hydrobünæ,*" p. 84); but the opercular characters do not belong to that family as defined by him, and are those proper to *Rissoininæ.*

Tatea is not synonymous with *Gabbia* (Tryon) as has been suggested by some conchologists. An examination of examples of the species, *G. australis* from its type-locality, proves that the surmise of Stimpson that the shell is a *Bythinia,* is correct, and justifies Brazier's interpretation of the generic characters, he having independently described the same as *Bithynia hyalina*; in our conjoint "Check List of the Freshwater Shells of Australia" it stands as *B. australis* (Tryon, sp.)

Eatoniella rufilabris occurs at South Grafton, Clarence River, N.S. Wales, and has been identified by E. A. Smith from specimens received from Brazier. Examples of the same have been determined by Tryon to be *Amnicola badia* (Gould), originally known from Banks Peninsula, New Zealand. However, the researches of Prof. Hutton on the New Zealand Hydrobünæ, in N.Z. Inst., 1882, p. 143, plate i., show that *Melania corolla* is a *Potamopyrgus,* the operculum of which has no internal process. I think we must vote Tryon in the wrong, more especially as the shells of the two species, *Eatoniella rufilabris* and *Potamopyrgus badia*, have much resemblance to each other; however, it must be admitted that Hutton has not shown that *Amnicola badia* (Gould) is a *Potamopyrgus*, though he has for *M. corolla*, which he regards as the same species.

Eatoniella is known by three species, inhabiting Kerguelen Island, one New Zealand, and one Australia.

The *habitats* of the last are as follow:—Usually on submerged weeds, or sheltering under stones at the margin in water-courses subject to tidal influences, though occasionally in fresh water, but rarely in waters wholly saline. It is a characteristic estuarine shell, but is present in some inland brackish waters; is abundant throughout Southern Australia and Tasmania, and extends to the Clarence River in New South Wales.

The following references supply the chronological history of the species:—

FAMILY RISSOININÆ.

GENUS EATONIELLA.

Eatonia, E. A. Smith, 1875 (*now* Hall, 1857).

Eatoniella, Dall, 1876 (*nom. mut.*).

Tatea, Tenison-Woods, 1879.

Dardania, Hutton, 1882.

EATONIELLA RUFILABRIS.

1863.—*Diala rufilabris*, A. Adams, Ann. Mag. Nat. Hist., p. 298.

1865.—*Diala rufilabris*, Angas, Proc. Zool. Soc., p. 174.

1875.—*Hydrobia rufilabris*, E. A. Smith, P.Z.S., p. 538.

1876.—*Bythinia huonensis*, Tenison-Woods, Roy. Soc. Tasmania for 1875, p. 77.

1878.—*Bythinia huonensis*, Tenison-Woods, Roy. Soc. Victoria, vol. xiv., p. 62.

1879.—*Bithynia huonensis*, Petterd, Journ. Conch., vol. ii., p. 93.

1879.—*Bithynella huonensis*, R. M. Johnston, Roy. Soc. Tasmania for 1878, p. 28.

1879.—*Tatea huonensis*, Tenison-Woods, Roy. Soc. Tas- Tasmania for 1878, p. 71.

1880.—*Tatea huonensis*, Tenison-Woods, op. cit. for 1879, p. 72.

1881.—*Tatea huonensis*, Tate and Brazier, Proc. Lin. Soc., N.S. Wales, vol. vi., p. 564.

1882.—*Tatea rufilabris*, E. A. Smith, Proc. Lin. Soc., London, vol. xvi., p. 268, tab. 7, fig. 19.

1883.—*Tatea huonensis*, Tryon, Syst. Conch., vol. ii., p. 259.

1887.—*Jeffreysia (Tatea) huonensis*, Tryon, Man. Conch., vol. ix., p. 397, tab. 60, fig. 94.

1889.—*Tatea rufilabris*, Petterd, Roy. Soc. Tasmania for 1888, tab. 2, fig. 1, p. 78.

1889.—*Tatea rufilabris*, Brazier, Jour. Conch., p. 72.

NOTES ON SOME PLANTS NEW TO TASMANIA.

[BY LEONARD RODWAY.]

Pomaderris elachophylla, F. v. M. A small leaved shrubby species of Dogwood. The infloresence is looser and more interrupted than in most plants of the genus. It had hitherto only been recorded from Victoria. Last September I found a patch of it growing near Longley, on the road towards Kingston.

Corysanthes bicalcarata, R. Br. This plant somewhat resembles C. fimbriata, but is easily recognised by its very different labial petal, and the leaf being red-brown beneath instead of primrose. I believe it had not been found south of the northern districts of N.S. Wales till lately, when it was discovered near the Scamander, and also at George's Bay, by Mr. Wm. Fitzgerald.

Pterostylis concinna, R. Br. This orchid, like P. nana, and P. prœcox, is delicately pubescent on the scape. It is easily recognised from its nearest allies by the labellum being rather shorter than the column, of equal breadth throughout, and broadly bifid at the apex. It is at present flowing freely on the heathy country between Bellerive and Beltana, and is, no doubt, common in many parts througkout the island, but overlooked. In the same locality P. prœcox was flowering. Together with these I found an orchid of an intermediate type. Instead of the basal rosette of leaves of P. concinna, or the leafless but bract-bearing scape of P. prœcox, it was between the two possessing true petisled leaves, but they were inserted on the scape, the lowest being the largest. With this intermediate type of foliage, there was an intermediate type of labellum; that organ was longer than that of P. concinna, and less so than P. prœcox, and at the same time it tapered towards the apex, as in the latter, but was bifid, thereby approaching the former. After making a copy of this interesting plant, I sent it to Baron von Müeller, but, unfortunately, the material was too meagre for him to come to any decision. For my part, I think lengthy observation will reveal many varieties between these two species, and possibly, also, between them and P. nana.

Chorizandra cymbaria, R. Br. This sedge was discovered some months ago, near Reminé, by Mr. Wm. Fitzgerald. Its principal home is W. Australia, but it has also been sparsely formed in N.S. Wales, Queensland, and once in Gippsland.

Gahnia rodwayi, F. v. M. This sedge is new to science, and was named after its finder, by Baron von Müeller. It is very common on hills from the fourth milestone on the Huon road to Mt. Nelson. It grows in dense, grassy clumps amongst the under shrubs. Its inflorescence is buried deep in the stems and leaves. Stock are particularly fond of it, and keep it eaten close down, except where protected.

Lepidosperma inops, F. v. M. Another sedge new to science. I have found it in quantity on the hill to the left of the new reservoir, Hobart, and no doubt it is common elsewhere. In general appearance it somewhat resembles L. lineare, but is smaller, and the spihelets, which are always few in number, are on very short stems, and are protected by long leafy bracts. It also seems a favourite with stock in the poor country it prefers, and the density of its growth, and its tenacity among the rocks, make it of some value as a fodder plant.

These last two, together with two more not yet named, and found by Mr. Wm. Fitzgerald in the neighbourhood of George's Bay, are at present in Baron von Müeller's hands, awaiting his leisure to be scientifically described.

ON NEW SPECIES OF TASMANIAN ARANEÆ.

By A. T. Urquhart, Corr. Mem. Royal Society
of Tasmania.

Fam. THERAPHOSIDÆ.

Gen. Macrothele, Auss.

Macrothele aculeata, sp. nov.

Mas.—Ceph. th., long, 7; broad, 5·1. Abd., long, 6; broad, 3·7; legs, 1, 4, 2, 3=24, 23, 22, 20 mm.

Cephalothorax, brownish-ochreous, median band dark chestnut-brown, trisected, central stripe and basal third of lateral attenuated; latter pair rapidly dilated, encroach over ocular region without any very determinate limits; thoracic indentation and marginal zone dusky; hairs black, short, sparse; lateral margins armed with a fringe of somewhat equidistant black spinelike bristles; two short oblique rows of similar bristles occur on posterior incline; ovate, rounded, and very slightly compressed beyond coxæ of first pair of legs; pars cephalica roundly truncated, convex, depressed visibly behind ocular elevation: *clypeus* projecting, height about equal to diameter and a-half of a fore-central eye; pars thoracica depressed by convex; indentation transverse, deep; caput and radial striæ broad, and somewhat shallow; profile, contour inclined gradually backwards, occiput arched.

Anterior row of *eyes* procurved, laterals close to margin of clypeus; central-pair posited on summit of elevation, less than their radius apart, separated from side-eyes of same row, which are oval, and nearly one-third larger, by an interval perceptibly shorter than their own diameter; posterior pairs in two sub-contiguous groups, median-eyes opalescent, much the smallest of eight, fully their breadth from anterior centrals; laterals oval, exceed hind-median pair by one-third, directed somewhat backwards, divided from fore-centre pair by a space surpassing their length.

Falces lake-brown; fairly-well haired on second half; linear, conical, project forwards at an angle of 20 deg.; profile arched; as long as the tarsus of second leg, not as stout as tibial joint.

Maxillæ orange-ochreous; inversely conical, similar in form to coxal joints of first pair of legs, inclined at same angle, palpi inserted at truncated extremity.

Labium brownish orange; small, about as wide as long; apex rounded.

Sturnum deep ochraceous; hairs black, coarse, moderately thick; ovate, lip at apex.

Legs, femora, patellæ and tibiæ olive-brown, longitudinally marked with brown-ochreous stripes, latter devoid of hair; outer lateral stripe broadest of series; streaks on tibiæ of fourth legs somewhat undetermined; metatarsi and tarsi brownish ochreous, base suffused with red-chestnut; legs stout, femora compressed; tibiæ cylindrical; pars tibialis of fore-leg projects from distal fourth-inner side, two stout, lake-brown, black tipped processes, directed towards each other; articulated extremity of front process cloven; posterior process stoutest, projects two sub-processes, upper—longest and strongest, somewhat spiral; lower—acuminate, apex reaches second half of upper sub-process, projects a long bristle; tarsi of first and second pairs somewhat turgid; scopula fine; femoral joints armed with bristle-like spines on superior aspect; tibiæ of two first pairs have 1, 1, 1, 2 beneath; metatarsus of first leg row of 3 at fore-end; of second 1, 2, 1, 3; tarsus of latter 1, 1, 1, small spines on inner side; spine armature of hind-pairs, including tarsi, more numerous and irregular. Superior tarsal claws—first pair, well curved, free end long; outer claw has 1 short basal tooth, 3 long, 4 moderately long open teeth; inner has only 7 teeth, being short of 1 medium tooth; inferior claw short, no teeth.

Palpi brown-ochreous, somewhat striped with olive-brown; humeral joint and lamina tinged with olive-green; stout; pars humeralis moderately compressed, in length fully equal to two-thirds of cubital and radial joints together; armed on superior aspect with row of spines; pars cubitalis cup-shape, more than half-length of penultimate article; latter joint cylindrical, truncated and somewhat constricted at extremity; projects from central third-outer side, a strong curved process furnished with numerous short, stout, black spines. Lamina strongly convex, somewhat quadrilateral, quite one-fourth longer than wide, inner margin impressed; superior fore-angle conical, prolonged forwards. Genital bulb connected to anterior end of lamina by a short stalk; viewed from inner side, lake-brown; discoid, prolonged into a long, flattish, sub-spiral, tapering apophysis, projecting backwards beyond the medial process, lake-brown above, pale brown-ochreous beneath; superior face of bulbous brownish-ochreous, discloses, apparently, two large, lake-brown, convex lobes; upper, or lobe proper, broad-pyriform; lower lobe sub-elliptical, formed by the tumid margin of bulbous.

Abdomen ovate, base truncated; rugose; fairly well furnished with black hairs, and stiff coarse bristles; light brown, passing into brownish-ochreous, beneath; dorsal aspect suffused with a fuscous-brown; series of ten large spots of the lighter brown shade, enclose an oval area occupying the posterior three-fourths.

Single example.

FAM. DRASSIDÆ.

Gen. LAMPONA, Thor.

Lampona sub-aquila, sp. nov.

Fem.—Ceph. th., long, 3·8; broad, 2·8; facial index, 1·2. Abd., long, 4·3; broad, 2·8; legs, 1—4, 2, 3=8, 6·5, 6 mm.

Cephalothorax dull lake-black; hairs fine, light brown, tolerably sparse; rugose; oval, slightly compressed beyond coxæ of first pair; cephalic part convex, truncation sensibly rounded, marked with a shallow medial groove; *clypeus* visibly shorter than breadth of a fore-centre eye; thoracic part convex, indentation longitudinal; profile-line slopes gradually backwards with a slight double arch.

Eyes from two procurved rows; posterior line rather the longest; centrals oval, visibly less than their diameter apart; nearly twice their length from laterals, which they sensibly exceed in size; median pair of anterior row surpass side-eyes in size by nearly one-third; dark, separated from each other by rather more than an eye's radius, about half that space from laterals of same row, which are removed from margin of clypeus by an interval equalling their own radius; side-eyes have the pearl-grey lustre of posterior centrals.

Falces lake-brown; transversely rugose; conical, somewhat divergent, directed forwards, base projects beyond plane of clypeus; length equal to digital joint of palpus; their space visibly surpasses breadth of hind row of eyes.

Maxillæ yellowish-mahogany; long, sub-linear, increasing gradually in breadth, obtusely truncated, inclined against lip; base free, pointed,

Labium lake-brown, passing into a yellowish mahogany colour; twice as long as wide, conical, apex abscinded, extends nearly to base of the truncated inferior angle of maxillæ; organ rugose.

Sturnum crimson-brown; studded with small papillæ projecting hairs; acute oval, fore end rather sharply constricted above coxæ of first pair.

Legs, two first pairs glossy, brownish-yellow; hind pairs lighter shade; have indications of dusky annuli on all joints except tarsal; moderately stout; tolerably well-furnished with light hairs; scopula moderately developed, extends to base of metatarsus; claw tuft projects beyond claws, which are stout, short, well-curved; about 4 open teeth.

Palpi yellowish-amber colour; fairly well armed with hairs; pars humiralis compressed, perceptibly longer than cubital and radial joints together; pars cubitalis cup-shape, shorter than penultimate and digital joints, which are of about equal length.

Abdomen elongate-oviform, base truncated, stalk exposed; somewhat thickly clothed with short, light-yellowish hairs; ground colour light olive-brown; posterior-third clouded with fuscous-green; elongate, light olive-green mark on central third; ventral region shade lighter than dorsal; rather thickly clothed light-brown hairs, grouped in open tufts, arranged somewhat in lines. *Corpus vulvæ* represents a large, sub-hexagonal, moderately elevated, areolated area, centre purple-chestnut, passing into amber-brown; inferior half occupied by a large, deep, sub-circular fovea, whose hind-margin is developed into a single scolopi; fore-margin interrupted by a reddish, black bordered, wide, linear-oval groove, which curves over the more tumid, superior half of corpus, terminating above the rima genitalis.

Single example, Launceston.

Gen. DRASSUS, Walck.

Drassus pellus, sp. nov.

Fem.—Ceph. th., long, 4·9; broad, 3; facial ind., 2·5. Abd., long, 5; broad, 3; legs, 1, 4, 2, 3=14·3, 12, 11, 9·7 mm.

Cephalothorax light burnt amber, greenish tone, facial area, striæ and marginal zone darker shade; fairly well clothed with a light pubescence, erect black hairs on caput; oval, moderately constricted beyond coxal joints of first legs; cephalic region dilated forwards, truncation visibly rounded, convex; *clypeus* in height fully equals breadth of a fore-centre eye; thoracic part convex, sides impressed above marginal zone; normal grooves shallow; profile-line dips at an angle of 50 deg. to thoracic junction from limit of caput, ascends somewhat shapely over cephalic region, which is rather prominently rounded on fore-part.

Posterior row of *eyes* somewhat strongly procurved, centrals visibly smaller than laterals of same row, removed rather further from them than they are from each other; anterior row slightly recurved, median-pair sensibly larger than lateral eyes, separated by an interval nearly equal to an eye's diameter, less than their breadth and a half from side eyes, which are placed obliquely on a strong tubercle, divided by a space surpassing the breadth of the hind and somewhat smallest eye, *Falces* greenish coffee-brown; hairs bristly, black, transversely rugose; conical, vertical, base turgid, projects beyond plane of clypeus, length equals metatarsus of second leg; stout, space exceeds breadth of ocular area.

Maxillæ light olive-brown, inferior margin streaked with chestnut-brown; armed with coarse erect black hairs; strong, gradually dilated, round pointed, straight.

Labium light olive-brown, clouded with red chestnut; conical; apex emarginate, three-fourths length of maxillæ.

Sturnum olive-brown; hairs whitish and black; ovate.

Legs light raw-sienna; armature, hairs whitish and black, latter most numerous, 4 or 5 rather slight; black spines on superior aspect of femora; patellæ project a bristle; tibial joints of first pairs, 8 slender spines on inferior surface; tibiæ of hind pairs, 5; metatarsal joints have about 12, including distal ring; scopula moderate, claw-tuft slight.

Palpi brownish-yellow, pars digitalis red-chestnut; moderately slender; furnished with black and light hairs; spines bristle-like, long and strong on digital joint.

Abdomen elongate-ovate; rather light olive-brown, pattern ill-defined—apparently a wide chocolate-brown stripe on basal half, double row of spots, similar shade, on posterior half. *Corpus vulvæ* brownish dark, chrome-yellow; posited on a large, somewhat triangular, elevation; rather more than half of the posterior side is occupied by a large, deep, trapizoidal pit, widest in front, posterior side, which exceeds the lateral in length, produced into a broad)(shaped septum; lateral and fore-margins prominent, beaded, centre-third of fore-margins produced into a lip-like projection representing a segment of a circle; curving round from angles of cavity towards the lip are two brown tipped, pointed, membranous processes, margins subclosed above; base of corpus turgid, wide and rounded in front, divided beneath lip by a broad, somewhat impressed, greenish-brown area.

Single specimen.

Drassus brunneolus, sp. nov.

Mas.—Ceph. th., long, 6; wide, 4·5; facial index, 3·1. Abd., long, 7; wide, 4·5; legs, 1, 2, 4, 3=23·5, 18·7, 17·5, 15 mm.

Cephalothorax fuscous; hairs light-yellow, adpressed, moderately thick, few black on caput; oval, constricted beyond coxæ of first pair; pars cephalica convex, lateral margins moderately arcuated, frontal margin sensibly rounded; depth of *clypeus* fully equals diameter of a fore-centre eye; pars thoracica convex, groove longitudinal; radial and caput striæ

—when wet—well defined; profile line represents a low arch on forepart of caput, descends gradually to limit of thoracic indentation, from thence dips rather abruptly to stalk.

Posterior row of *eyes* rather strongly procurved; median-pair sensibly surpass laterals in size, removed about one-fourth further from them than they are from each other; anterior row moderately recurved; centrals more than twice as large as hind pair, fully their radius from each other, separated by twice that interval from side-eyes of same row, which are oval; laterals posited obliquely on a tolerably strong common tubercular prominence, divided by a space nearly equalling breadth of posterior eye, which is about one-third smaller than anterior eye.

Falces lake-black; hairs yellowish and black, moderately long and thick; transversely rugose; conical, inclined very perceptibly forwards, base projects beyond plane of clypeus; somewhat turgid and grooved on inner side; length equals the pars tibialis of a third leg; about as stout as the femur of the second.

Maxillæ dilated forwards, round-pointed, slightly inclined towards *labium*, latter conical, abscinded, two-thirds length of maxillæ; organs dark chocolate-brown, apices brownish-yellow.

Sturnum greenish coffee-brown; oval.

Legs, thighs orange-brown, first pair tinged with lake; patellæ, tibiæ — metatarsi reddish-orange, more or less—especially two anterior pairs, tinged with lake-brown; strong; fairly-well furnished with longish black hairs; femoral joints have 8 or 9 spines; tibiæ of I.—II., 10 spines, of III.—IV., about 8; metatarsi of first and second legs have respectively 7—8; hind pairs about twelve; scopula and claw-tuft tolerably strong.

Palpi, humeral joint brownish-orange, of somewhat even breadth, barely surpasses cubital and radial together in length; pars cubitalis colour of former article, somewhat campanulate, equals penultimate joint in length, projects moderately strong bristles; radial joint lake-chestnut, armed with stout bristles, rather stronger than the pars cubitalis; obliquely truncated from apex of fore-process; superior angle projects three strong processes, directed forwards; centre process stoutest and longest, extends over base of clava; lateral processes form a line above central; inferior angle produced into an obtuse-conical process. Lamina lake-chestnut, well furnished with light hairs and long bristles; narrow ovate. Base of genital bulb represents a yellowish-brown, striated, sub-crescentic lobe, of somewhat even breadth; extremity of outer horn membraneous, ovate, dilated, visible surface concave; projecting from within concavity is a short, yellowish process; inner horn turgid, projecting, sharply recurved, and developed into a rich mahogany-brown, continuous membrane, which covers superior aspect of bulbous, its prominently arcuated margin fitting closely to the crescentic lobe; anterior fourth free, tapering, curves outwards and backwards.

Abdomen elongate-oviform; light olive-brown; markings purple-brown, ill-defined; basal-half exhibits an acute-elliptical figure, bordered with a deeper shade; posterior-half marked with about five pairs of spots; indications of oblique striped en lateral margins; ventral region purple-brown, defined by light hairs; shield elongate, yellowish-brown, bordered with light hairs. Abdomen clothed, rather thickly, with light yellowish and erect brown hairs.

Single specimen.

Gen. CLUBIONA, Str.

Clubiona elaphines, sp. nov.

Mas.—Ceph. th., long, 6; wide, 4·1; facial ind., 3·1. Abd., long, 6·5; wide, 4; legs, 4, 1—2, 3=16, 15, 11·5 mm.

Cephalothorax brownish-orange, passing into lake-chestnut on cephalic part; moderately clothed with fine, adpressed, pale yellowish and black, bristle-like hairs, sub parallel, lateral compression at caput slight.

Posterior and anterior rows of *eyes* sensibly and equally procurved; hind row of about equal size; centre-pair visibly the most distant apart; median eyes of front row more than twice size of hind pair, two-thirds their breadth apart; fore-laterals exceed hind pair by one-third, interval dividing them is fully equal to one-half the space separating the anterior pair from centrals of same row.

Falces brownish-orange, lake-reflections; few hairs; rugulose; sub-conical, anterior-fourth somewhat constricted, project much beyond plane of clypeus, inclined farwards, divergent.

Maxillæ light red-chestnut; long, bent outwards, second-half dilated, superior—external angle obliquely truncated; inferior angle acutely truncated.

Labium and maxillæ concolorous; rather more than twice as long as wide, sub-parallel, roundly emarginate.

Sturnum brownish-yellow; ovate; eminences opposite coxæ.

Legs shade lighter than cephalothorax, metatarsal and tarsal joints of I.—II. deeper tone; armature, fine, adpressed, pale yellowish, and erect black dairs; spines black.

Palpi colour of legs; short, slender; humeral joint incrassated forwards; spine armature I., III. on fore-third; cubital joint sub-linear, more than one-third length of former article, projects a moderate bristle; radial joint about half length of cubital, produced on outer side into a strong, flattish, clathrate, blackish-lake process, directed forwards, upcurved, equal to article in length; pars digitalis, lamina oval, fairly haired, few bristles; bulb sienna-brown, few vein-like, dark brown lines; regulose; elongate, moderately tumid, posterior end cleft; covered by a dusky, wrinkled, membrane on inner side; fore-half—rather more—longitudinally intersected by a deep groove; extremity of bulbous concave, deeply emarginate; inner lobe, which extends nearly to apex of lamina, drawn out into a wide tapering spiral, bright orange-red apophysis, lying across extremity of bulb; outer lobe produced into two processes, upper simi-pellucid, conical; plainly visible immediately beneath it is a broad, rounded, black process, contiguous to a pale pyriform lobe.

Abdomen ovate, moderately convex; tolerably well clothed with fine light-yellow and erect black hairs; yellowish stone-colour, markings blackish-violet; on basal-third is an elongate figure of no determinate form, followed by a series of about seven, sub-touching, broad lanceolate marks, decreasing in size to anus; directed inwards from lateral borders are several large tooth-like projections.

Fem.—Ceph. th., long, 7; wide, 4·9. Abd., long, 8·5; wide, 4·9; legs, 4, 1—2, 3=18, 16, 13 mm.

Cephalothorax shade darker than males, visibly more dilated.

Eyes do not differ essentially from males.

Falces brownish-lake; transversely rugose; conical, gibbous at base in front, project moderately.

Maxillæ and *lip* lake-brown; normal form.

Sturnum brownish-orange, brown spots opposite coxæ.

Legs, in colour and armature resemble males. Femora of first and second legs have I. I., II. slender spines, of hind pairs, I., I., III.; patellæ of III.—IV. one side-spine; tibiæ of I. II., 2, 2 beneath; of III.—IV., 7 somewhat irregular spines; metatarsi of I. II. have 2 basal; of III.—IV., have respectively 6—8; distal rings of 6 spines.

Palpi colour and armature of legs.

Abdomen in form, colouration, and specific pattern does not differ essentially from the male. *Corpus vulvæ* sub-circular, inferior-half moderately elevated, transversely wrinkled, light reddish-brown, fuscous stains; centre of superior-half occupied by a large, yellowish, circular fovea intersected by a pale, somewhat Y shaped costa, border colouration of upper-half, somewhat membraneous, broad, ridged, constricted in front at base of costa; dark fore-margin projects over the rima genitalis.

Four specimens, Domain, Hobart.

Clubiona apiata, sp. nov.

Fem.—Ceph. th., long, 3·4; wide, 2·5; facial index, 2. Abd., long, 6; wide, 3·2; legs, 1, 4, 2, 3=16·3, 12, 11, 7 mm.

Cephalothorax light ochreous-brown; cephalic region exhibits medial and lateral bands lightly tinted with olive-green, former dilated, tapers to fovea, broken at limit of caput by a chestnut-brown lanceolate figure; latter bands interrupted; sparingly clothed with a pale pubescence and darkish hairs; nearly as long as the patellary and tibial joints of second leg; pars cephalica depressedly convex, sides abrupt; height of *clypeus* less than diameter of a fore-centre eye; thoracic part low, fovea very shallow; profile-contour inclined backwards with a visible curve to thoracic indentation, from thence dips to stalk more abruptly.

Eyes on narrow dark rings; posterior row sensibly procurved; median-pair scarcely larger than laterals, a little more distant from them than they are from each other; anterior row slightly recurved, centrals visibly exceed hind-pair in size, form with them a trapezoid narrowest in front; posited rather closer to one another than they are to side-eyes; latter pair separated by an interval equal to about three-fourths their diameter.

Falces ochraceous, faint olive-green streak; haired; subconical, fore-third somewhat constricted and divergent; project forwards; length rather surpasses their space, latter interval exceeds breadth of hind-row of eyes.

Maxillæ shade darker than legs; moderately haired; second-half dilated; superior external angle prominent, less acutely truncated than inferior angle, base of which nearly reaches lip.

Labium light brown; length rather exceeds breadth; sides rounded; apex abscinded; nearly two-thirds length of maxillæ.

Sturnum colour of coxæ; faint olive-green, triangular marks between the slight eminences.

Legs slender; shade lighter than cephalothorax, tinged at articulation of joints with red-lake; hairs fine, sparse; few slender black spines on femoral, tibial, and metatarsal joints; spines on penultimate article strongest; claw-tuft moderately developed; scopula somewhat scant; hairs fine.

Palpi paler than legs; hairs short, fine; slender; length, 4 mm.

Abdomen oviform, elongate; ground colour olive-green, closely spotted with stone-coloured, lake-tinted, lobate flecks; dorsum stained with lake, exhibits on posterior-third a brown-pink, linear lanceolate figure, which throws off a series of fine, dark-lake coloured lines, converging above the yellowish spinners; lateral margins and ventral region free from lake stains; fairly well clothed with short, whitish hairs. *Corpus vulvæ* represents a hemispherical elevation, truncated in line with the rima genitalis, concave within; of a pale ochreous-brown, clouded with olive-green.

Single example.

Fam. THERIDIIDÆ.

Gen. LINYPHIA, Latr.

Linyphia melanozantha, sp. nov.

Mas.—Ceph. th., long, 3; broad, 2·2. Abd., long, 3; broad, 2·2. Legs, 1—4, 2, 3=9, 8, 6·7 mm.

Cephalothorax rich ochreous-orange, lake reflections; marginal zone, ocular area, and wide stripe on clypeus olive-green; very sparsely furnished with black hairs; rugulose; broad-ovate, slightly compressed forward; pars cephalica semi-oval, convex, eye eminence prominent; three very perceptible medial grooves on occiput; *clypeus* projecting, height less than two-thirds depth of facial space; pars thoracica sub-circular, moderately convex, centrally depressed; indentation somewhat T-shape; caput and radial striæ fairly well marked; profile-contour gradually inclined backward, sensibly arched over occiput; thoracic curve more prominent.

Posterior row of *eyes* sensibly recurved; median pair about one-third smaller than side-eyes, posited obliquely, separated by an interval fully equal to the breadth of an eye; removed from laterals by twice that space; anterior row recurved; centrals dark, less than one-half size of hind pair, occupy a somewhat shorter space, rather more distant from side-eyes than they are from each other; latter pair large, have the pearl-grey lustre of posterior centrals seated obliquely on a common black tubercular prominence, sub-touching.

Falces olive-brown; transversely rugulose; somewhat slender, linear-conical, extremities bent a little outwards; retreating base level with plane of clypeus; length equal to depth of facial space.

Maxillæ ochreous-orange, fore-third suffused with olive-green, rather longer than wide, obtusely pointed, inclined over *labium*; latter organ reddish-brown; broad oval.

Sturnum ochreous-orange, brown margins; triangular, broad.

Legs yellowish-orange; femora and tibiæ of two first pairs almost entirely suffused with blackish-olive; metatarsi and tarsi have a dusky hue; indications of annuli at base of penultimate articles; tibiæ of third and fourth legs have irregular evanescent rings at base; moderately clothed with strongish, black hairs; tibial and metatarsal joints armed with black bristle-like spines; superior tarsal claws; first pair strong, somewhat evenly curved; two close basal teeth; eight curved, open teeth; inferior claw sharply bent; two teeth, outer strongest.

Palpi yellow-orange; stout; pars humeralis nearly as long as clava, incrassated forwards; cubital joint—viewed from above linear—roundly pointed, narrower than humeral joint, projects two black bristles; pars radialis quite as long as former article, laterally compressed; projects from above a very remarkable large, fuscous, bifurcating process, base and branches flat; leading branch about as wide as stem, gradually and moderately dilated forwards; apex truncated, incurved; lateral branch shortest, projects at a right angle towards clava, orbicular-spathulate; base of process armed with strong, long, black bristles; lamina fuscous-olive, moderately furnished with coarse, black hairs; rugose elongate-ovate; base obtusely truncated, upturned above into a short, pointed process; genital bulb represents a somewhat oblate-spheriod, basal end crossed by a transverse, olive-green callus forepart, traversed by a brown-lake callus; these bands are divided by a wide, yellowish groove, exhibiting beneath a dark sub-callus; the turgid anterior aspect of bulb is drawn out into a very wide, greenish membrane, reaching to apex of clava.

Abdomen inversely ovate; blue-black; spinners brownish-yellow; hairs black, coarse, somewhat sparse.

Fem.—Ceph. th., long, 2·2; wide, 2. Abd., long, 3·2; wide, 2·3. *Masc.* Ceph. th., long, 2·6; wide, 2·3. Abd., long, 4; wide, 3. Legs, 1-4, 2, 3=7, 6, 5·3 mm.

Cephalothorax glossy, deep amber colour; ocular area and clypeus suffused with olive-green; marginal streak dark, sparingly furnished with coarse, black hairs; rugulose; pars cephalica convex, semi-oval; eye eminence prominent; lateral index about equal to facial; *clypeus* inclined forwards, height, less than two-thirds depth of facial space; pars thoracica circular, moderately convex; posterior incline depressed; radial striæ well defined, caput grooves less pronounced; profile-line dips from limit of caput to thoracic junction at an angle of 30 deg., ascends moderately, with a sensible curve, to hind-row of eyes.

Posterior row of *eyes* sensibly recurved, nearly straight; centre-pair fully one-third smaller than laterals, rather more distant from them than they are from each other, an interval slightly exceeding their own diameter; anterior row recurved; median pair dark, about one-half size of hind-centrals, form with them a trapezoid, the front line of which is shortest; visibly more remote from one another than they are from side-eyes; laterals of fair size, have the pearly lustre of posterior centre-eyes posited obliquely on a strong, common tubercle, sub-contiguous.

Falces yellow-brown, olive-green hue; fore-half and sides suffused with a deeper shade; linear-conical, retreat perceptibly; not fully as stout as the femur of a second leg, as long as the pars digitalis of palpus.

Maxillæ brownish-yellow, mottled, fore-half passing into olive-brown; well developed, somewhat linear, round-pointed; inclined over *labium*; latter organ shade darker; breadth surpasses length by one-third, somewhat rounded.

Sturnum deep chestnut-brown; glossy; broad-cordate.

Legs orange-ochreous; first pair, basal two-thirds of femora olive-green; tibiæ suffused with same shade; metatarsi and tarsi slightly suffused, faint basal ring on former articles; markings on second legs resemble first, except that the broad bands on femora are reduced to basal annulations; third and fourth pairs have very faint indications of annuli; hairs black, somewhat coarse and sparse; few bristle-like spines. Superior tarsal claws—first pair, 15 open comb-teeth forming an even line with point of claw; inferior claw sharply bent, two tolerably strong teeth, outer longest.

Palpi, colour and armature of legs; pars digitalis fuscous-green; rather longer than cephalothorax; palpal claw moderately curved, 11 open comb-teeth extending length of claw.

Abdomen broad-ovate, projects over base of cephalothorax; bluish-black; sparingly clothed with coarse black hairs. *corpus vulvæ* yellowish mahogany colour, fuscus clouds about base; represents a large transverse, sub-oval, plano-convex, turgid projection; superior margin somewhat prominent, projects over the rima genitalis.

Numerous examples differing somewhat in their cephalic shading and leg markings.

Linyphia quindecim-punctata, sp. nov.

Fem.—Ceph. th., long, 2·1; wide, 1·5. Abd., long, 4 wide, 2. Legs, 1, 2, 4, 3=10·6, 10, 9, 7 mm.

Cephalothorax ochreous-brown; dorsal aspect of caput dark chocolate; sides of thorax clouded and streaked with olive-green; fovea dark, very sparingly clothed with hair; cephalic part oval, facial and lateral index about equal breadth; *clypeus* projecting, one-half depth of facial space; thoracic part oval, convex; fovea oval, longitudinal, deep; normal grooves, somewhat slight; profile-line moderately curved across occiput, dips forward; thorax rises sensibly above plane of caput, slopes at an angle of 40deg. to stalk.

Eyes of tolerable and nearly equal size, on dark rings; posterior row sensibly procurved; median pair visibly more distant from laterals than they are from each other, an interval scarcely equalling an eye's diameter; anterior row recurved; centrals dark; smallest of eight removed from one another by more than an eye's radius; fully their diameter from side pair; laterals surpass posterior median pair in size, posited obliquely on a dark, common, moderately strong tubercular elevation, contiguous.

Falces brownish-ochreous, clouded with olive-green; subconical, divergent, retreating; base projects sensibly beyond plane of clypeus; three strong teeth on outer row; inner four small, moderately stout; length slightly exceeds the pars digitalis of palpus.

Maxillæ ochraceous, base chocolate; rather longer than broad, inclined towards one another.

Labium greenish-chocolate, apex yellowish; broad-oval, apex tumid, everted.

Sturnum olive-green; cordate nearly as wide as long.

Legs slender, ochreous-yellow, annuli faint olive-green; femoral, tibial, and metatarsal joints of I.—II. have three rings, III.—IV. pairs two; hairs light, sparse; femora, patellæ, and tibæ moderately armed with slender spines.

Palpi and legs concolorous, long, slender; cubital and radial joints project strongish bristles.

Abdomen elongate-oviform; ground colour olive-drab; folium ovate, occupies dorsal aspect, flecked, more especially along margins, with lake-tinted creamy-coloured dots; displays round border 15 large brown spots, separated by about their own breadth; lateral margins show dull flecks and brown blotches. *Vulvæ* ochraceous, faint, longitudinal, olive-green stripes, two red-brown spots at extremity; moderately haired; represents a remarkably long, curved, membraneous scapus, projecting abruptly from a slight elevation, and extending backwards nearly to spinners; of even width, convex above, concave beneath, margins grooved, apex acutely emarginate. Free part of base or sub-scapus cleft, projects over the rima genitalis; dark spot within basal curves; beneath the superior scapus, and extending beyond it, is a yellow translucent, very slender stylus, apex ladle-shape; springs from base of sub-scape.

Single example.

'*Linyphia sub-luteæ*, sp. nov.

Fem.—Ceph. th., long, 2·1; wide, 1·6. Abd., long, 3·2; wide, 3. Legs, 1, 4, 2, 3=12·8, 8·6, 8, 6 mm.

Cephalothorax, light ochreous-brown; medial streak wide, without clearly defined limits, chocolate-brown; lateral margins speckled with similar tone; broad-ovate, slightly compressed at caput; pars cephalica convex, roundly truncated; eye prominence moderate; height of *clypeus* rather exceeds one-half depth of facial space; pars thoracica prominently convex; fovea deep elongate-oval, longitudinal; radial striæ fairly well marked; caput grooves well defined; profile line rises with a sensible curve from margin of eye area to limit of caput, from thence represents an abrupt curve to stalk.

Eyes on black rings, enclose an oval space; centrals of posterior row removed rather further from laterals than they are from each other, an interval fully equal to an eye's breadth; median-pair of anterior row dark, scarcely as large as hind pair, form with them a sub-quadrilateral figure, rather longer than broad; divided from side eyes by a space equalling their radius; laterals visibly the smallest of eight, opalescent; posited on a moderate sized, common dark tubercle, sub-touching.

Falces, yellowish, amber colour; slender, conical; inclined forwards, base in line with plane of clypeus; length equal to depth of facial space.

Maxillæ ochreous-brown; long, linear-spathulate; somewhat bent over lip.

Labium, lightly suffused with olive-green, short, about twice as wide as long, rounded, everted.

Sturnum, pale brownish-olive, metallic reflections; heart-shape; slight eminences opposite coxæ.

Legs, light ochreous-brown; central and distal annulations of a deeper tone on tibæ and metatarsi; hairs dusky, tolerably thick; bristle-like spines on the pars petellaris and tibialis.

Palpi, colour and armature of legs; cubital joint shorter than radial; digital rather longer than humeral.

Abdomen oviform, projects well over base of cephalothorax; hairs yellowish, short, fairly thick; ground colour light brown, approximating to olive-green; central-third occupied by an elongate, diamond-shaped figure, stained with dark chocolate, margins pale brownish-chrome.

Corpus vulvæ ochreous-brown; transverse oval, moderately elevated; summit occupied by two rather large, broad-oval fovea, divided by a septum fully one-half their breadth; four black processes project outwards from within fovea; outer pair sub-touching margin, short, second pair separated by septum, corneous, moderately stout, in length about equal to diameter of fovea, curved towards superior border of corpus, inclined towards each other.

Single specimen.

Linyphia nitens, sp. nov.

Fem.—Ceph. th., long, 1·2; broad, 1. Abd., long, 2·3; broad, 2. Legs, 1, 2, 4, 3=6·9, 5·5, 4·2, 3 mm.

Cephalothorax fulvous, sparingly speckled with lake, fovea and radii olive-green, lateral margins lightly pencilled with a similar tint. Hairs sparse. Ovate, lateral compression at caput slight; pars cephalica depressedly convex, roundly truncated, lateral index fully equals two-thirds of facial; *clypeus* vertical, depth scarcely surpasses diameter of a fore-centre eye; pars thoracica convex; fovea transverse oval; normal grooves fairly perceptible; contour of profile rises from stalk at an angle of 40 deg., slopes forwards with a perceptible curve.

Posterior row of *eyes* pearl-grey, visibly procurved, equidistant, centrals nearly one-half larger than laterals of same row, separated by scarcely an eye's interval, less than their diameter a half from fore-centrals; anterior row dark, moderately recurved, about equal distances from each other; median pair rather the smallest of eight, on dark rings, divided by an interval exceeding their breadth; lateral eyes posited obliquely on dark, contiguous tubercles, nearly radius of the fore-eye apart, latter eye intermediate in size between the hind-lateral and fore-central.

Falces brownish-amber colour; strong, conical, gibbous at base in front, vertical; length exceeds digital joint of palpus, rather stouter than thigh of a leg of first pair.

Maxillæ greenish-yellow, dappled with olive-green; nearly as broad as long, rounded, taper to base; separated by an interval about equal to their own breadth.

Labium bluish-black; one-third wider than long, strongly everted.

Sturnum brown, suffused with bluish-black, nearly as wide between second pair of coxal joints as long, tapers somewhat rapidly to a tail-like prolongation between coxæ of fourth legs.

Legs pale fulvous, greenish reflections; distal olive-brown annulations on tibial, metatarsal and tarsal joints. Hairs sparse, spines bristle-like, 1 or 2 on femora of I—II; patellæ project 1; tibiæ 2 or 3; metatarsi less; superior tarsal claws —1st pair, long, slender, slightly curved, about 18 short, close teeth; inferior claw sharply bent, 1 long tooth.

Palpi pale-brown, radial joint greenish; armed with bristles; palpal claw long, slender, somewhat straight, tip bent, 6 short open teeth.

Abdomen oviform, depressedly convex, greenish gamboge, more or less stained with reddish-lake, spotted with silver lobate specks—few golden, more or less confluent along margin of dorsal band; latter broad at posterior end, tapers forward to a mere streak, displays two cross-bars on basal curves; broader part exhibits 6 or 7 ill-defined arcuate-bars; the indigo-brown colour of ventral region encroaches in a wedge-shape into lateral margins from posterior end; shield sub-oval, border light brown, silvery flecks. *Corpus vulvæ* represents a dark brown, sub-circular elevation; each lateral slope indented by a small, shallow, ovate fovea, whose apex is directed inwards; fovea connected by a strong, dark, V-shaped costa, whose extremity reaches over the edge of the somewhat abrupt incline above the rima genitalis.

Two examples.

Gen. THERIDIUM, Walck.

Theridium pilatum, sp. nov.

Mas.—Ceph. th., long, 2; wide, 1·5. Abd., long, 2·2; wide, 1·7; legs, 1, 2, 4, 3= 12, 8·2, 7·5, 4·9 mm.

Cephalothorax brownish-stone, passing into ochreous-orange about facial region, speckled with olive-brown; median band dilated on caput, mottled with olive-brown; hairs very sparse; ovate, lateral compression slight; cephalix part convex, round-pointed; height of *clypeus* equal to rather less than one-half depth of facial space; thoracic region convex, fovea sub-oval, deep; caput and radial striæ moderately defined; profile-contour represents a double arch; thoracic curve which rises sensibly above plane of caput, dips abruptly; cephalic part forwardly inclined.

Eyes on dark rings, of moderate and nearly equal size; posterior row procurved, centrals divided by nearly an eye's interval, removed one-fourth more than that space from side-eyes; anterior row recurved, median pair dark, largest of eight, separated from one another by scarcely more than an eye's diameter, and from side-eyes by an interval sensibly less than their radius; laterals smallest of eight, seated obliquely on a common, lake-brown tubercle, sub-touching.

Falces ochreous-orange; slender, conical, vertical, length equal to breadth of ocular area.

Maxillæ light yellow-brown, inferior margin and apex opalescent; moderately wide, acutely-spathulate, inclined towards each other.

Labium somewhat the colour of maxillæ, one-third broader than long, sub-quadrate, rounded.

Sturnum broad-cordate; fulvous, clouded with olive-brown.

Legs yellowish stone-colour, ochreous-orange reflections; annulations chestnut, evanescent; pre-apical and apical on femora of I.—II.; distal rings on femora of III.—IV.; tibiæ of first pair 4 rings, of hind pairs central and apical annuli; metatarsal joints have central and apical rings, basal indicated. Hairs somewhat sparse; bristle-like on patellary-tibial joints.

Palpi humeral cubital joints light stone brown, penultimate article and clava ochreous-orange; pars humeralis somewhat stout, exceeds in length two following joints by one-third; cubital somewhat campanulate; pars radialis much enlarged and roundly pointed on superior side; two latter articles furnished with black bristles; laminæ bulbi ovate, tapering, directed towards each other, moderately armed with strong, black hairs; genital bulb, viewed beneath from inner side, mitriform; inferior side shortest, displays on its face an oval, shield-like callus; projecting from within bulbous, and extending nearly to extremity of clava, is a wide, semi-pellucid apophysis, sub-spiral, abruptly truncated, inferior angle shortly prolonged, cyathiform.

Abdomen oviform; hairs sparse; olive-brown, spotted with large and small creamy-coloured flecks; fore-half occupied by a lanceolate figure, somewhat suffused with dull-red, marked with large fuscous spots; margin, confluent creamy flecks; posterior incline exhibits a sub-oval band, closely spotted with normal flecks; lateral margins marked with a longitudinal, interrupted fuscous band, gradually enlarged posteriorly, curves round spinners, confluent beneath.

Fem.—Ceph. th., long, 2; wide, 1·5. Abd., long, 3·2; wide, 2·8. Legs, 1, 2, 4, 3=10·8, 9, 8, 5 mm.

Cephalothorax brownish stone-colour; median band sharply constricted at fovea, mottled olive-brown; side border wide, somewhat acute-crenate, similar shade; hairs coarse, sparse, mostly on caput; pars cephalica convex, frontal line round-pointed, lateral index one-third shorter than facial; *clypeus* inclined moderately forwards, depth nearly equal to half facial space; pars thoracica ovate, moderately convex; fovea oval, longitudinal; normal grooves tolerably well defined; contour of profile rises from stalk at an angle of 45 deg., inclined forwards.

Eyes do not differ essentially from males.

Falces colour of cephalothorax; conical, inclined sensibly forwards; base scarcely projects beyond plane of clypeus; in length fully equal to the pars digitalis of palpus.

Maxillæ normal stone-colour, two fore-thirds suffused with a deeper shade; as long as falces.

Labium light olive-green; oval, length rather surpassed by width.

Sturnum greenish stone-colour, wide olive-brown border; broad cordate, perceptible eminences opposite coxæ.

Legs, slender; light brownish stone-colour; femoral, tibial and metatarsal joints have more or less undefined olive-brown distal and pre-apical annulations; sparingly armed with dusky hairs; patellæ and tibiæ of two first pairs have respectively 1—2 slender bristles.

Palpi shade paler than legs; slender; few hairs and bristles.

Abdomen sub-ovate, base rather prominent, grooved; ground colour approximating to brown-pink, passing into a pale tone beyond folium, numerous small stone-coloured flecks and dark brown spots; rather more than half of dorsum occupied by a lanceolate figure—apex directed backwards, spotted—especially the haft, which about equals the lance-head in length, with fuscous dots, margins creamy, stained with orange-red about lance-head; lateral margins have three interrupted fuscous, nearly vertical, bands, first band terminates in a large spot on posterior side of stigmata, interspace occupied by creamy flecks; three spots occur close to spinners, centre brown, oblong; outer spots consist of a group of light flecks. *Corpus vulvæ* greenish stone-colour; represents a moderately prominent sub-triangular elevation, whose extremities curve over the orange-brown stigmata; comprised within the shallow, somewhat oval, central depression are two not very clearly defined sub-circular fovea divided by a broad septum, about their equal in diameter; projecting from within each fovea are two processes, forming a transverse line; outer pair black, cylindrical, short; inner pair perceptibly the widest, brownish-lake, linear spathulate, concave on fore-side, fully four times as long as outer processes.

Two males and a female.

FAM. ENYOIDÆ.

GEN. HABRONESTES, L. Koch.

Habronestes flavipedes, sp. nov.

Fem.—Ceph. th., long, 3·6; wide, 2·5. Abd., long, 4·5; wide, 2. Legs, 4, 1, 2, 3=11, 10, 9·9, 9 mm.

Cephalothorax dull, deep olive-green, facial space, wide medial band, and radii approximating to fuscous-black; sub-marginal fringe of sparse white plumose hairs, small patch close to posterior centre-eyes and hind-slope; rugulose, studded with minute papillæ; pars cephalica somewhat quadrate, strongly convex, sides steep, ocular eminence tolerably prominent, sub-circular; *clypeus* retreats visibly, depth exceeds half length of eye-area; pars thoracica elevated, slopes somewhat abruptly from the deep, narrow indentation, sides moderately rounded; caput and radial striæ well defined, shallow; contour of profile rises from thoracic junction at an angle of 45 deg., represents a level line to eye-region broken by two slight arches, crown of thoracic part rather above plane of occiput.

Eyes in two procurved rows; posterior line nearly semicircular; eyes equal in size; centre-pair rather more distant from laterals than they are from each other, an interval scarcely equalling their own breadth; anterior row moderately procurved, median pair one-third smaller than hind-centrals, divided by a space equal to an eye's diameter; fore-laterals a third smaller than centrals of same row, separated from them by an interval less than half their radius, and from side-eyes of hind-row by fully one-half their diameter.

Falces dull lake-brown, conspicuous red-lake streak down inferior margin of fore-third; fringed with white hairs; conical, anterior kind (rather more) divergent vertical, profile arched.

Maxillæ chestnut-brown, inferior margin fulvous; nearly as wide as long, of somewhat even breadth, pointed, directed towards each other, divided by an interval nearly equalling breadth of lip.

Labium fuscous, margin amber colour; triangular, apex abscinded, everted, less than half length of maxillæ.

Sturnum dark brown-lake; hairs fine, sparse; broad ovate.

Legs bright yellowish-orange, coxæ suffused with olive-brown; femoral, tibial and metatarsal joints of fourth pair almost entirely suffused with lake-brown; moderately strong, do not differ much in length or strength; hairs fine, somewhat sparse; spines black; about five strongish spines on superior aspect of femora, basal long, erect; tibiæ of I.—II., 2, 2 bristle-like spines beneath; metatarsi 2, 2 stronger spines on inferior surface; tibial joints of III.—IV. have 7 somewhat irregularly placed spines; metatarsi about 6, terminating with ring of 5.

Palpi colour and armature of legs tolerably long and slender.

Abdomen oviform, base roundly truncated, second half dilated, pointed; dull fuscous-black; thickly studded with small papillæ; hairs black, sparse; ventral region light olive-brown. *Vulva* reddish-brown, clouded with a deeper tone; triangular-obovate, moderately elevated; transversely rugose; superior half occupied by two large sub-pyriform foveæ, divided by a wide rapidly dilated septum, bordered by bead-like costæ; shows two mussel-shaped indentations, contiguous to costæ.

Single specimen.

FAM. TETRAGNATHINÆ.

Gen. TETRAGNATHA, Latr.

Tetragnatha quadri-notata, sp. nov.

Fem.—Ceph. th., long, 3·5; wide, 2·4. Abd., long, 5·2.; wide, 3·5. Legs, 1, 2, 4, 3=19·3, 13, 11, 8 mm.

Cephalothorax fulvous, ocular area lake coloured; dorsal band dappled with olive-brown, lake vein-like streaks; bi-crenate, fore-half much the widest, ends abruptly at fovea; encloses four large subpyriform, fulvous spots, first pair encroach between dorsal and lateral eyes; sub-marginal band coloration of median. Some examples exhibit olive-brown stripes in radiating depressions; very sparingly furnished with hairs; pars cephalica depressedly convex, sides steep, roundly truncated, eye-prominence moderately developed; facial index exceeds lateral by one-fourth; transverse sub-oval fovea in centre; pars thoracica broad ovate, rises above plane of caput, posterior incline depressed; fovea elliptical, longitudinal, deep; normal grooves somewhat shallow; profile-line ascends at an angle of 30deg. from dorsal eyes to limit of caput, dips rather more abruptly to thoracic junction.

Eyes of moderate and nearly equal size; posterior row slightly procurved; centrals less than one-third larger than laterals, separated by an interval exceeding an eye's radius, removed from side eyes by their breadth; anterior row recurved; median pair visibly smaller than laterals, rather further from each other than they are from the latter pair—an interval sensibly surpassing their breadth; lateral eyes posited on a strong, common, dark tubercle, sub-touching.

Falces yellowish mahogany; sub-conical, base projects beyond plane of clypeus; fore-third divergent, plainly longer than the pars digitalis of palpus, fully as stout as the femur of a fore-leg, retreat sensibly.

Maxillæ ochreous-brown, pale apices; spathulate, superior angle rather prominent, inclined towards each other.

Labium darker shade; sub-oval, everted, nearly as long as wide, about half length of maxillæ.

Sternum mahogany-brown; cordate, eminences opposite coxæ.

Legs fulvous, conspicuously spotted with light olive-brown and lake dots, latter predominate, annuli, olive-brown; suffused with dark-lake; markings vary somewhat in individual examples; fairly well furnished with outstanding, black hairs; all joints, except tarsi, tolerably well armed with yellowish, dark-tipped, slender spines. Superior tarsal claws —1st pair, evenly curved, 12 close teeth; inferior claw, sharply bent, free end directed forwards, 2 close teeth.

Palpi light fulvous, radial and digital joints ringed; palpal claw long, 7 teeth.

Abdomen oviform; light fulvous, posterior three-fourths of dorsal aspect more or less suffused with lake, flecked with rather large and small lake-coloured dots; larger spots have a dense shade; basal end somewhat unspotted; folium extends from about second quarter to anus, posterior two-thirds reddish-lake, marginal spots resolved into sinuate border; flecks on petiole intermixed with black-lake streaks and dots; spots on ventral region resolved more or less into longitudinal streaks; light ground colour encroaches from base dividing the wide quadrate median stripe from vulva and sides; spinners light purple. *Corpus vulvæ* red-chestnut; elevated, represents the segment of a circle, centre-third somewhat rounded, tumid, projects forwards, discloses beneath a moderately wide, dark bordered, sub-linear septum, intersecting two large mussel-shaped foveæ.
Several examples.

FAM. EPEIRIDÆ.

Gen. EPEIRA, Walck.

Epeira phalerata, sp. nov.

Fem.—Ceph. th., long, 3; wide, 2·5; facial index 1. Abd. long, 6; wide, 4. Legs, 1, 2, 4, 3=3·2, 7·4, 7·8, 5·5 mm.

Cephalothorax light olive-brown, speckled, especially about normal grooves, with olive-green; wide median and submarginal bands tinted with olive-green; eye-eminence reddish-brown; hairs white, silky, tolerably long and thick; cephalic part moderately convex, ocular eminence prominent; lateral index one-third shorter than facial; height of *clypeus* just surpasses interval of a fore-centre eye; thoracic part moderately convex, sides well rounded; posterior incline occupied by a trisected area, apex emarginate, limited by thoracic indentation; caput and radial striæ somewhat shallow; profile contour represents an even arch, fore and hind slope about equally steep.

Eyes do not differ greatly in size, posterior centrals intermediate between anterior median pair and laterals; hind row moderately recurved; centre pair posited somewhat obliquely, divided by nearly an eye's breadth, about their space and a quarter from side eyes; anterior row strongly recurved; centrals separated from each other by less than their diameter and a half, perceptibly more than that interval from hind pair, rather less than their space from laterals; latter pair seated obliquely on low eminences, scarcely their radius apart.

Falces coloration of cephalothorax, basal half mottled; linear conical, gibbous in front, vertical, stout, in length fully equal to digital joints of palpus.

Maxillæ breadth somewhat surpassed by length, enlarged and prominently rounded forwards, inclined over *labium*, which is rather wider than long, round-pointed; organs dark chocolate-brown, apices fulvous.

Sturnum indigo-chocolate; broad-cordate, eminences opposite coxæ.

Legs light yellow-brown; femora marked with three wide annulations, lake-chocolate on fore-pairs; approximating to olive-brown, and interrupted on hind-pairs; patellary joints of third and fourth legs show two rings, first greenish; tibiæ two annuli, basal narrow, brown; anterior rings olive-brown, breadth more than half length of article; central and distal annulations of a greenish colour on metatarsi; anterior half of tarsi olive-brown; somewhat sparingly furnished with light hairs; spines yellowish, slender, moderately numerous; two first and two hind-pairs of about equal strength; thighs dilated, compressed; patellæ-tibiæ of I.—II. stout, latter cylindrical.

Palpi light yellow-brown, olive-brown annulations at base of humeral joints, and at extremities of cubital-radial; two fore-thirds of digital joints olive-brown; armature, light hairs, black spines.

Abdomen oviform, base pointed, somewhat aplanate above, projects well over base of cephalothorax; humeral tubercles depressedly conical; posterior pair transverse, low, rounded; hairs, white, short, thinly interspersed; dorsal region cream-colour, lightly clouded with olive-brown; closely speckled with small testaceous spots; dorsal band wide, basal fourth yellowish, mottled with brown, bounded by a testaceous line, uni-dentate; dentations encroach over, the otherwise cream-coloured tubercles; longitudinally interrupted by a wide, creamy, red bordered stripe, exhibiting a brown and red medial mark; dorsal band somewhat compressed from humeral tubercles, widely dentate; fore-third of constricted part, speckled, cream colour, displays an olive-brown medial stripe, traversed by three streaks; posterior two-thirds yellowish-olive, mottled with olive-green; three small impressed dots arranged in a recurved line occur on verge of anterior slope; five pairs of blue-black impressed spots on constricted part of band; two fore-pairs most pronounced, form a trapezoid narrowest in front, on the cream-coloured area; lateral margins gamboge colour, speckled with the normal red dots; inferior half mottled with olive-brown, displaying a somewhat acute-crenate outline; fore-part of ventral aspect occupied by a brown, semi-circular patch, bordered on outer side with yellow; posterior part fuscous. *Corpus vulvæ* black-brown; represents a projecting, triangular, transversely rugulose, aplanate scape, more than twice as broad as long, margins wide, revolute, increasing in breadth at apex; superior margin of corpus developed into a rather wide membraneous costa, curving somewhat over the rima gentitalis, centrally depressed.

Single example.

Epeira obscurta, sp. nov.

Fem. ceph. th., long, 2·7; broad, 2; facial index, 1·5. Abd. long, 5; broad, 4. Legs, 1, 2, 4. 3=10, 9, 8, ·3, 6 mm.

Cephalothorax lake colour; hairs white, tolerably long and sparse; pars cephalica convex, roundly truncated, eye-prominence tolerably strong; facial index exceeds lateral by one-third; mamiform elevations moderately developed; *clypeus* perceptibly surpasses diameter of a fore-centre eye; pars thoracica somewhat depressed, well rounded; fovea sub-oval; normal grooves rather shallow; contour of profile represents a low arch.

Eyes tolerably small; posterior row straight; median pair posited obliquely on large circular, elevated fuscous spots, divided by an interval equal to twice an eye's breadth and a half, their space and one-third from laterals; anterior row only moderately recurved; centrals sensibly larger than hind pair, a little more distant from them than they are from each other, an interval visibly shorter than the space separating the hind centre eyes; laterals rather smaller than posterior median pair, divided by a space scarcely equalling their radius, seated obliquely on rather low eminences.

Falces light, dull ochreous-brown; hairs fine, whitish; sub-conical, vertical, profile curved, first half prominent, length equal to interspace between anterior lateral eyes; as stout as the pars femoralis of a fore-leg.

Maxillæ fuscous, apicus olive-green; breadth somewhat surpassed by length, obtusely pointed, directed towards each other.

Labium, sub-triangular, rather wider than long, more than half length of maxillæ, similar colour.

Sturnum fuscous; sparingly clothed with white adpressed hairs; cordate, perceptible eminences opposite coxal joints.

Legs brownish-gamboge, femora of two first pairs suffused with red-lake; of third pair central and distal reddish rings; femora of hind legs have anterior three-fourths suffused with lake-brown; indications of annuli on other joints; moderately strong; sparingly armed with whitish hairs and slender yellowish spines.

Palpi colour and armature of legs.

Abdomen broad oviform, depressed, humeral tubercles obtuse-conical, directed outwards and upwards; posterior tubercles obtuse; central of first row rather the longest, much the widest; tubercular projection of second row somewhat surpasses upper tubercle in size; lowest represented by a strong wrinkle; ground colour very pale raw-sienna, orange tinge, lightly suffused—mainly on folium, with a pale olive-brown; speckled with rather faint lake flecks; margins of folium somewhat undetermined, crenate, yellowish-olive; three pairs of impressed spots, fore-pairs form a trapezoid narrowest in front; centre pair largest and darkest; dorsal aspect laterally bordered by interrupted, deep olive-green bands; ventral colouration represents various shades of brown encroaching into lateral margins; *corpus vulvæ* brownish-yellow; sub-quadrate, elevated, deeply emarginate at base of scapus, which is of a light yellow-brown colour, projects nearly one-half its length beyond corpus, transversely wrinkled, aplanate, first half ovate, moderately wide; basal end of second half oval, about half breadth of first part, fore-half compressed, vermiform; corpus laterally margined by reddish-brown, ear-shaped, well-developed costæ, discloses at posterior end of shallow cavity bordered by costæ, two somewhat pyriform lobes.

Single specimen.

Epeira sub-flavida, sp. nov.

Fem.—Ceph. th., long, 4; broad, 3; facial index, 1·8. Abd., long, 8; broad, 6. Legs, 1, 2, 4, 3=12, 11·4, 11, 9 mm.

Cephalothorax deep fulvous, slightly speckled with chestnut-brown; eye prominence yellow; sub-parallel streaks on caput exhibit two spots; fovea dark; radii of thorax shaded with the normal rich chestnut; hairs yellowish, sparse; fore-half of cephalic part somewhat depressed above, squarely truncated, ocular eminence prominent; lateral index nearly equals facial; depth of *clypeus* scarcely equals diameter of a fore-centre eye; thoracic part moderately convex, well rounded, fovea sub-oval; radial and caput-striæ tolerably strong; profile-contour represents a low arch; ocular prominence level.

Eyes on dark rings; posterior row recurved, line across hind margin of centre pair intersects laterals; median eyes separated by fully their own breadth, about their space and one-quarter from side eyes; anterior row rather more distinctly recurved; centrals visibly more than one-third larger than hind pair, rather more distant from each other; interval exceeding an eye's diameter than they are from posterior pair, less than their space from side eyes; latter pair nearly equal hind centrals in size, posited obliquely more than their radius apart.

Falces light fulvous, suffused with brown at extremities; few white hairs; conical, vertical; length equals breadth of anterior row of eyes; stout.

Maxillæ fulvous, shaded with brown; rather longer than wide at fore-end, pointed, inclined towards *labium*; latter organ has a deeper tone than maxillæ, one-half their length, oval.

Sturnum deep fulvous, spotted, border suffused with chestnut-brown; cordate.

Legs yellowish, perceptible green tinge, somewhat speckled with brown; light olive-brown annulations on fore-end of femora; patellæ colour of annuli; central and apical rings on tibial and metatarsal joints more or less obliterated; hairs yellowish, short; spines yellowish, base dark, moderately numerous; tibial spines less than diameter of article in length; legs of tolerable strength, I., II., IV. of nearly equal length.

Palpi fulvous; fore-end of pars digitalis red-chestnut; armature light hairs and spines.

Abdomen triangular-ovate, base rounded; humeral tubercles mamiform, project upwards and outwards; the aplanate dorsal slope terminates with a wide, somewhat compressed, pointed tubercle; inferior tubercular prominence more obtusely pointed; ground colour, bright chrome-yellow, more or less suffused with olive-brown, closely speckled with lake; folium tapers to posterior tubercle, margins acute-crenate, olive-brown; second half suffused with olive-brown; median streak narrow, dark, crossed by three arcuate bars. Acute apices of humeral tubercles red-chestnut, orange-yellow tips conspicuous. Four pairs of impressed spots, two anterior pairs blue-black, well-defined, represent a trapezoid narrowest in front. Abdomen crossed by a series of small, shallow, pale, dark-centred fovea, most pronounced on lateral margins; ventral aspect fulvous, speckled, approximating to olive-brown about sides, which display several vertical pale olive-green lines. *Corpus vulvæ* represent a large triangular, longitudinally depressed scape, lying close to abdomen, apex directed towards sturnum; exhibits seven distinct yellowish stone-coloured wrinkles—the extremity, which was somewhat damaged, apparently terminates with three black, and several less pronounced reddish wrinkles; base of scapus roundly emarginate, project a brownish, gradually dilated septum, which curves round the incised margin of corpus; latter represent two olive-brown lobes—bordering the rima genitalis, surpassing in length, but otherwise not differing essentially from wrinkles of scapus.

Single specimen.

Gen. ARACHNURA, Vinson.

Arachnura trilobata, Urq.

Described and figured in the "Transactions of the New Zealand Institute." Vol. xvii. p. 37.

Average length of *female* about 9 mm., *male*, 5 mm.

Cephalothorax glossy black; prominently sculptured. *Legs* moderately long, rather slight; pale greenish-yellow, annulations broad, olive-black. *Abdomen* oval, moderately wide, convex, terminates posteriorly in three blunt, transversely wrinkled protuberances; centre-process much the longest and stoutest, flexible; glossy brown-black, median band tolerably wide, silvery, stained with lake, extends to base of tail-like process; cross-bar and apex of latter organ reflect the normal metallic lustre.

A female example of this handsome species was contained in *Mr. Morton's* collection. This species is not very uncommon in New Zealand; varies somewhat in the colouration of the legs and specific pattern.

Gen. ÆREA, Urq.

Ærea magnifica, sp. nov.

Mas.—Ceph. th., long, 2·5; broad, 2; facial index, 1·8. Abd., long, 3; broad, 2·8. Legs, 1, 2, 4, 3=7·3, 6·8, 6, 4 mm.

Cephalothorax ochraceous, green tinge; cephalic region suffused with purple-lake; thoracic groove, lateral borders of caput, and thorax stained with lake-purple; studded with papillæ, the larger grouped somewhat in lines; hairs dull silvery and deep golden, somewhat sparse; sub-aplanate, sides tolerably abrupt, base prominently rounded, lateral compression at caput moderate; frontal angles stout, trapezoidal, directed forwards and outwards, about as long as broad in front; *clypeus* pointed, retreating, depth fully equal to space occupied by anterior centre-eyes; thoracic indentation subcruciform, shallow; radial striæ faint; caput grooves more defined; profile line slopes back from dorsal eyes at an angle of 30 deg. beyond first half, base rounded; dips more abruptly across eye region.

Posterior row of *eyes* very strongly procurved; median pair placed obliquely on well-developed, dark-ringed tubercles, which are posited on crown of caput, separated by an interval equalling space occupied by fore-centre eyes; removed from laterals by their space and a quarter, and from anterior median pair, which they equal in size, by scarcely their space; anterior row visibly procurved; median eyes seated on tolerably prominent sub-tubercular eminences, divided by an interval fully as wide as their diameter, plainly more than their space from side eyes; laterals placed less than the radius of a hind eye apart at extremity of frontal projections; fore and hind eyes are respectively the largest and smallest of eight.

Falces brownish, suffused with purple-brown; transversely rugose; sub-conical, retreat rather sharply, base barely in line with plane of clypeus, length about equal to their space.

Maxillæ yellowish-chestnut, apices pale slate; broad-spathulate, inclined towards each other.

Labium shade darker than maxillæ; triangular.

Sturnum brownish-purple, ovate, moderately studded with papillæ, projecting hairs.

Legs, anterior pairs yellowish - chestnut, lake - brown reflections, femora clouded with dark-brown, evanescent, reddish-chestnut annulations on the patellary and tibial joints; posterior pairs yellow-orange, second half of femora occupied by lake-brown rings; tibiæ and metatarsi have interrupted lake-brown basal annulations; two first pairs of nearly equal stoutness, much the strongest; tarsus of first leg rather shorter than metatarsus, somewhat elevate, furnished with close-lying black hairs; armature, light, fine, sparse hairs; light brown, tolerably strong spines; 7 or 8 on femoral joints, including two stout, curved spines on superior aspect of fore-half; patellæ 3; tibiæ and metatarsi of I.—II. about 16 long spines, of IV. respectively 6-10; third pair rather more sparingly spined.

Palpi, ochreous-yellow, wide, broken, fuscous rings on humeral joint; latter article compressed, fore-half incrustated; length equal to the cubital and radial joints together; pars cubitalis oval, projects a moderately strong bristle; pars radialis campanulate, plainly longer and wider than former article, armed with numerous long bristles. Lamina ochreous-yellow, passing posteriorily into lake brown; rather sparingly haired; broad-oval, base developed into a turgid costa, curved sharply forwards; posited immediately in front of basal end of costa, outer side, is a large, conspicuous, lake-black, crescent-shaped, sub-free process. Bulbous genitalis mahogany-brown, reticulated—viewed from front, sub-obovate, fore-third deeply cleft beneath lamina; a moderately long, orange-brown, linear apophysis curves over the somewhat pointed base; most observable appendages beneath bulb are two strong, black close-lying, curved, spine-like apophyses, projecting from outer margin of concavity transversely across bulb.

Abdomen sub-aplanate, sides rugose, base rounded in outline; tapers from humeral tubercles to posterior-third, which is constricted to rather less than half the greater breadth; basal margin studded with a series of six small tubercles, centre pair greenish-yellow, much the largest, visibly more distant from humeral tubercles than they are from each other; humeral tubercles of moderate size, obtusely conical, opalescent, streaked with lake; upper side exhibits a remarkable pearl-like spot; integument developed immediately behind humeral tubercles into sub-tubercular elevations not differing very essentially either in form or colour from the former; projecting from second quarter of dorsal aspect is a large backward curved process, resembling the horn of a rhinoceros—about as wide at base as long; length equal to more than one-fourth of abdomen; orange-ochreous, speckled with red-brown, apex yellow; posterior side exhibits a yellow, white-haired medial stripe, bordered with a dark edge, rising from posterior third is a similar but much smaller process, flanked by two pearl-like spots; hind tubercular projections in two rows; laterals longest, somewhat elongated; directed outwards, lake-brown, pale median streak; centre tubercle much the smallest of the row, obtuse-conical, tubercle of second row pointed, rather wider than long, fully half length of laterals; two centre tubercles yellow, marked with red-lake; ground colour blue-black; the pattern—which resembles the handsome border of an Oriental shawl—is of an orange colour picked out with lake, clothed with golden and silver hairs; basal cross-band occupies one-third of dorsum; fore-half of band exhibits a series of circles enclosing blue spots, separated by about their own diameter; second half represents a centrally interrupted band of somewhat even width, figured with blue and lake sinuate lines; design on posterior two-thirds consists of a series of intricate lines enclosing two unfigured sub-oval patches, which flank the larger process.

Two male specimens.

Fam. THOMISIDÆ.

Sub-Fam. Philodrominæ.

Gen. Philodromus, Wlk.

Philodromus luteo-virescens, sp. nov.

Fem.—Ceph. th., long, 3·5; broad, 3. Abd., long, 5; broad, 3. Legs, 1—2, 4, 3=16, 12·5, 11·5 mm.

Cephalothorax ochreous-yellow—probably tinged with green; facial space ochraceous; rather sparingly furnished with short, yellowish, and black hairs; pars cephalica moderately convex, frontal line sensibly rounded; height of *clypeus* equal to three-fourth diameter of a fore-centre eye; pars thoracica broad-ovate, moderately convex; indentation longitudinal; normal grooves faint; profile line inclined and visibly arched across caput, dips to thoracic junction at an angle of 50 deg.

Posterior row of *eyes* sensibly procurved, equi-distant—centrals slightly surpass laterals in size—posited on rather low, fuscous tubercles, directed somewhat backwards; anterior row perceptibly recurved; centrals fully one-third larger than hind pair, closer to one another—scarcely more than an eye's breadth—than they are to the latter pair; lateral eyes placed on moderate, dark tubercular eminences, divided from each other by an interval nearly equalling their diameter and a half; fore-eyes separated from anterior centrals by scarcely their radius.

Falces light ochreous; conical, vertical, base projects beyond plane of clypeus; space exceeds breadth of hind row of eyes, length equal to about three-fourths of space.

Maxillæ colour of coxæ; gradually dilated, rounded, strongly convex, moderately inclined towards each other.

Labium tinged with green; length surpassed by breadth, rounded.

Sturnum greenish-yellow; broad-cordate.

Legs ochraceous, green tinge; patellary, tibial, and metatarsal joints have lake reflections; metatarsi and tarsi longitudinally streaked with lake-brown; moderately furnished with whitish and black bristle-like hairs; slender bristles and spines on femoral, tibial, and metatarsal joints; tibial spines of first pair one-third length of article. Scopula rather sparse; claw-tuft moderate. Tarsal claws—1st pair, tolerably strong, about 20 somewhat even comb teeth, free end sharply curved.

Palpi paler shade than falces, pars cubitalis tinged with lake. Palpal claw short, well curved; 5 teeth.

Abdomen elongate-oviform; yellowish pea-green; dorsal streak, evanescent posteriorly, moderately wide, defined by somewhat faint yellowish flecks. Hairs sparse, short, whitish and black. On ventral surface is a conspicuous patch of black hairs, flanked by spots of white, visible amongst the hairs is the *vulva*, which represents a simple depressed area occupied by two dark foveæ, intersected by a)(shaped septum.

Single example.

FAM. LYCOSIDÆ.

Gen. LYCOSA, Ltr.

Lycosa albo-pilata, sp. nov.

Mas.—Ceph. th., long, 2·8; wide, 1·8. Abd., long, 3; wide; 1·7. Legs, 4, 1—2, 3=8, 6·5, 6 mm.

Cephalothorax brown-pink, yellowish hue round margins; stretching across thorax are two broad, fuscous bands—outer border sinuated, the deeper fuscus shade encroaches more or less over sides of caput and ocular area; lateral margin dark, narrow; hairs white and orange-yellow, dense, patchy, short, black, and erect on dorsal line; ovate, lateral margins of caput gradually compressed forwards; pars cephalica aplanate, sides abrupt, squarely truncated; *clypeus* in depth scarcely equals interval separating fore-central eyes; pars thoracica elevated, indentation longitudinal; radial striæ well defined; caput grooves shallow; profile line dips abruptly posteriorly, slopes slightly forwards with a visible curve to second row of eyes.

Anterior row of *eyes* moderately procurved; centre pair exceeds side pair by nearly one-third, visibly more than the diameter of an eye apart, less than that interval from laterals; eyes of second row greatly surpass in size that of first line, interspace not equal to an eye's diameter and a half; dorsal pair more than one-half as large as the latter pair, removed fully one-fourth further from each other than they are from eyes of second row.

Falces brownish-yellow, second half clouded with dark olive-green; sub-conical, fore-third divergent, retreat sensibly.

Maxillæ moderately enlarged forwards, sub-elliptical, curve somewhat over *labium*, which is about as wide as long; rounded; organs light yellowish-brown, slightly suffused with olive-green.

Sturnum light yellow-brown, margins stained with brown; ovate.

Legs greenish stone colour, passing into olive-brown towards extremities, brown-pink reflections along superior aspect; three ill-defined olive-green rings on femora, tibiæ, and metarsi; indications of annuli on patellary joints; hairs erect, black, and yellowish; fairly-well armed with spines on femoral, tibial, and metatarsal joints.

Palpi armed with black bristles and white hairs; pars humeralis greenish stone colour, olive-brown basal and apical rings; length fully equal to the two preceding articles, of even breadth, projects two long bristle-like spines on medial line; four short spines form a transverse group on fore-end; cubital joint ochraceous, dusky clouds; viewed from above, elliptical; pars radialis olive hue, clouded, cup shape, quite one-third shorter than former article; digital joint surpasses humeral in length; lamina creamy-ochreous, figured with two interrupted, brownish cross bars; hairs fine, sparse; ovate. Bulbous genitalis brown, turgid behind, membraneous in front, margin drawn to a sharp point on outer side; viewed from beneath, discloses three easily perceptible appendages projecting from within; nearest to basal end is a semi-transparent, membraneous, tapering organ; immediately beyond are two red-brown, dark-bordered, large, sub-linear apophyses of about equal length and breadth; first and inner apophyses stretch across face of bulbous to anterior third of clava, posterior side concave, transversely rugose, margins incurved, apex truncated, fore-angle curved upwards; hind-angle prolonged, bent downwards; outer margin produced about midway into a short, pointed, backward-curved process; front apophysis crosses hind and curves back on posterior side of the above-mentioned process; somewhat aplanate above, convex on inferior side, apex moderately pointed.

Abdomen oblong-ovate; dull, greenish, gamboge colour, moderately spotted and streaked with olive-black; spots on posterior incline resolved into somewhat undetermined arcuate lines; outline of folium evanescent; latter design has a deeper tone than ground colour, sharply constricted at posterior fourth; basal half exhibits a broad triangular mark, dappled with black-brown, encloses a linear-lanceolate figure, thickly clothed with white and ochreous-yellow hairs, latter predominate round margin. Abdomen clothed with short, whitish and yellowish hairs, increaing in length on lateral margins.

Fem.—Ceph. th., long, 3; broad, 2·1. Abd., long, 3·1; broad, 2·1. Legs, 4, 1—2, 3=10, 7·7, 6·7 mm.

Cephalothorax brown-pink; thoracic part displays two broad brown bands—outer border undulating, encloses a tapering dorsal mark; ocular area and sides of caput clouded; tolerably well clothed with white and ochreous-yellow hairs, few black, bristle-like hairs on caput; ovate moderately compressed forwards; facial index surpasses lateral by one-fourth; pars cephalica depressedly convex; sides abrupt; height of *clypeus* exceeds interspace between fore-centre eyes; dorsal aspect of thoracic part aplanate, sides somewhat steep; groove longitudinal; radial striæ tolerably well defined; contour of profile rises from stalk at an angle of 60deg.; slopes visibly across occiput; slightly curved between third and second row of eyes.

Anterior row of *eyes* procurved; median pair sensibly larger than laterals; one-third further from each other than they are from side-eyes—a space about equal to their own diameter; eyes of second row tolerably large, rather more than the breadth of an eye from each other; dorsal pair visibly smaller than eyes of second line, removed about one-third further from one another than they are from latter pair.

Falces brownish-yellow, two fore-thirds suffused with olive-brown; conical, inclined sensibly towards maxillæ; base projects moderately beyond plane of clypeus; length slightly exceeds their space, and nearly equals radial and digital joints of palpus together.

Maxillæ brownish-yellow, clouded, pale round apex, moderately dilated, well rounded, curved somewhat towards each other.

Labium shade darker; about as broad as long, sub-oval.

Sturnum dull brown-pink, clouded round margins with olive-brown; ovate.

Legs light brownish-yellow, sensibly tinged with olive-green; annuli olive-green, more or less interrupted, not well defined; about 4, 2, 3, 3 rings on the respective joints; armature does not differ essentially from males.

Palpi and legs concolorous, annulations somewhat broken, wide; two on humeral, single rings on three following joints; hairs light; pars humeralis armed with five strongish spines on superior aspect, three shortest arranged in a transverse line at fore-end, cubital joint rather shorter than penultimate article, projects a slender bristle; radial joint visibly shorter than digital, two latter joints furnished with bristles.

Abdomen oblong-ovate; rather thickly clothed with close-lying, white and yellow-ochreous hairs; more sparingly with erect black; ground colour brownish-yellow, tinge of olive-green; fuscous spots and marks, more specially on lateral borders of anterior half; indications of cross arcuate lines on posterior incline; fore-half displays an oblong-lanceolate figure thickly covered with white and yellow-ochreous hairs, latter occur chiefly on margin, which exhibits three pairs of fuscous dots; terminal third much compressed by a V-shaped dark-brown mark. *Corpus vulvæ* red-chestnut; plano-convex elevation, transversely wrinkled, apex truncated; margins at base prolonged forwards and inwards towards each other, convex, apices rounded, glossy brown; orifice of corpus closed by a large, protruding, creamy-brown, tumid, tongue-like scape, nearly as wide as long; projecting very perceptibly beyond lateral elongated margins.

Lycosa festiva, sp. nov.

Fem.—Ceph. th., long, 3·8; wide, 2·9. Abd., long, 3·8; wide, 2·5. Legs 4, 1, 2, 3=14·3, 10·5, 9·9, 9 mm.

Cephalothorax yellow-ochreous; a bright red-lake figure tapers from hind row of eyes to limit of caput, lake colour encroaches over facial space; thoracic part displays two wide fuscous bands—tri-serate on outer side, curving from base to fore-end of caput; lateral margins lightly pencilled with lake; hairs white, somewhat sparse, patchy on dorsal line; six strong bristles project from margin of clypeus; broad ovate; pars cephalica sub-quadrate, sides roundly impressed, ocular region somewhat elevated; *clypeus* in depth equal to rather more than one-half of space occupied by anterior row of eyes; pars thoracica moderately convex; groove longitudinal; radial striæ fairly well defined; contour of profile ascends from thoracic junction at an angle of 40 deg., slopes slightly forwards, dips abruptly from verge of second row of eyes.

Eyes on black spots; anterior row strongly recurved; centrals about twice as large as side-eyes of same row—latter pair broad-oval—more distant from one another than they are from laterals, an interval visibly less than their radius; eyes of second row sensibly larger than fore-centrals, divided by a space equal to three-fourths their diameter, less than twice that interval from anterior median pair; dorsal eyes do not differ essentially in size from fore-centrals, posited obliquely on rather strong, lake-black, lateral processes, interval separating them nearly equal to twice the space that divides them from eyes of second line.

Falces ochreous-yellow, traversed by a wide, olive-green, centre band; furnished with white and long black hairs; conical, retreat visibly, stout; slightly shorter than the pars digitalis of palpus.

Maxillæ straw colour; breadth surpassed by length; superior angle rounded; inferior, obliquely truncated; inclined towards one another.

Labium shade deeper than maxillæ, wider than long, subcircular, abscinded.

Sturnum ochreous-brown, wide brown border; broad oval; fairly well clothed with white hairs.

Legs, inferior aspect dark stone colour, densely clouded with olive-green; superior surface ochreous-yellow, sharply defined from lower; two first pairs suffused—above, with lake; thighs of third pair somewhat spotted, of fourth suffused with lake; patellary joints streaked; tibiæ, metatarsi and tarsi spotted; hairs white and yellow, fine, erect, black, sparse; about 6 black spines project from femora; tibial joints of first and second legs have 2, 2, 2 beneath; metatarsi 2; spine armature of hind pairs more numerous and irregular.

Palpi dull gamboge colour, marked with olive-green and lake spots or broken annuli; hairs whitish, sparse; black, bristle-like spines on all joints; pars humeralis of even width; cubital joint sub-campanulate; radial shorter and stouter than digital.

Abdomen oviform; hairs white, tolerably thick, erect, black, sparse; gamboge colour, brownish tone obtains on posterior incline; sparingly spotted with reddish dots; medial figure broad, gradually dilated from base, abruptly truncated, unicrenate at termination of second third; encroaches into second half of dorsum; of a soft fuscous black, laterally bordered by a dense, narrow fringe of whitish-yellow hairs; indications of brownish, longitudinal streaks on hind slope; lateral margins exhibit two dusky longitudinal stripes; ventral region bounded by brown dots; spinners brown-pink. *Vulva* normal shade, represents a simple longitudinal elevation, bounded below the genital aperture by a moderately developed, transverse ridge.

Single example.

Fam.—ATTIDÆ.

Gen.—PLEXIPPUS, C. Koch.

Plexippus validus, sp. nov.

Mas.—Ceph. th., long, 5; broad, 4; height, 2·2. Abd., long, 4·5; broad, 4. Legs, 1, 4, 2, 3=13, 11·4, 11, 10·8 mm.

Cephalothorax lake-brown, densely suffused with black; hairs sparse, black, orange-red, and white, two latter fine, not very perceptible; iredies orange; clypeus fringe yellowishl sparse; rugulose; pars cephalica plane, limited by a tolerably deep transverse indentation, sides rather abrupt; depth of *clypeus* about equal to interval separating anterior centre eyes; pars thoracica moderately dilated, one-third longer than cephalic part.

Anterior row of *eyes* moderately recurved, laterals fully one-third size of centrals, removed from them by an interval scarcely equalling their own diameter; median pair about half that distance apart; eyes of second row visibly closer to fore laterals; dorsal eyes rather smaller than laterals, equidistant from a row shorter than cephalothorax at that place, square of ocular area one-third wider than long.

Falces blackish-lake; transversely rugose; vertical, flatly convex, of somewhat even breadth, divided by a rather wide obovate space; extremity of falces somewhat squarely truncated, anterior fourth—inner side drawn out into an obtuse, sharply upturned, flattish process, whose apex is twisted forward, project two black tooth-like sub-processes; inner row of teeth long, close together, stouter than outer; latter project from a strong subquadrate process, broader than long; centre tooth longest and stoutest.

Maxillæ lake-chocolate, fading into a brownish tone at angles; anterior half sharply dilated—especially superior angle; rounded, slightly inclined towards each other.

Labium conical, more than half length of maxillæ, colouration similar.

Sturnum brownish-yellow, approximating to olive-green; hairs whitish; ovate.

Legs, femoral joints fuscous-lake; patellæ and tibiæ of I.—II. lighter shade; metatarsi orange-lake, white basal and distal annulations of a deeper tone; patellary and tibial joints of III.-IV. legs have a more yellowish shade than the fore pairs. indications of rings on tibiæ; metatarsi and tarsi brownish-yellow, dark annulations on former articles. White hairs short, sparse; black, numerous, long; fairly-well armed with spines. Legs stout I.-II., III.-IV. of about equal strength; patella and tibia of first leg cylindrical, slightly surpass cepholothorax in length, latter article one-sixth longer than former; metatarsus and tarsus just exceed tibia.

Palpi and legs concolorous; well armed with long, pale yellow and black hairs; first part of the pars humeralis compressed, second half gradually incrassated in length, exceeds by one-fourth cubital and radial joints together; pars cubitalis, viewed from above, sub-quadrate, radial joint somewhat shorter and narrower than latter article, obliquely truncated beneath, outer margin prolonged forwards into a into a black spine-like down-curved process, equal to half length of joint; pars digitalis equals humeral joint in length; lamina elongate-ovate, convex, well haired; genital bulb yellowish-brown, clouded with olive-brown, well developed, conical, apex projects backwards into cavity beneath radial joint; base truncated, of a creamy-brown colour, encircled by a black, corneous, spine-like costa, broad on inner side; concave, centre elevation deeply incised.

Abdomen ovate; dorsal region grayish-fulvous, pattern without any very determinate limits; more thickly, but less brightly haired than female.

Mas. max. length, 10·5; min. 8. *Fem.* max. length, 9·8; min. 8 mm.

Fem.—Ceph. th., long, 4; wide, 3. {Abd., long, 5·2; wide 3·8. Legs, 4, 3, 1—2=9, 8,7·5 mm.

Cephalothorax deep lake, passing into lake-black on borders of eye area and sides. Hairs long, black, orange-red and white; former mostly on fore-part of caput; clypeus fringe somewhat sparse, whitish. Elevated, cephalic part plane, inclined, limited by a very perceptible transverse depression; *clypeus* in height scarcely equal to radius of a lateral eye; thoracic part only moderately dilated, sides rather abrupt; scarcely one-third longer than cephalic part; dips at an angle of 40deg. to stalk.

Eyes do not differ essentially from males, except that in the first row they are comparatively and actually rather closer to each other.

Falces lake-brown; few white hairs; transversely rugulose; of somewhat even breadth, project forwards at base, vertical; in length equal interspace between lateral eyes.

Maxillæ chocolate-brown, inferior angle pale, few black hairs; dilated somewhat rapidly at second half, rounded.

Labium three-fourths length of maxillæ, similar colour, conical.

Sturnum light fulvous; hairs sparse; ovate.

Legs yellow-brown—first pair somewhat suffused with lake—three olive-brown annuli on femora, basal ring narrow, central and apical broad; indications of rings on patellary joints, tibiæ, basal, and pre-apical annulations; metatarsi have basal and distal. Patella and tibia of first leg equal in length, together one-fourth longer than metatarsus and tarsus. Femoral and patellary joints armed with short, black spines; tibiæ of I.—II. have 2, 2 beneath second half, 1 side spine; metatarsi 4, 4 at each extremity; tibiæ of III.—IV. about 4 spines towards fore-end; metatarsal joints 4 at base. Tarsal claws—1st pair, long, somewhat depressed in centre, free end well curved; outer claw 12 or more tolerably stout teeth; inner about 30 fine, close teeth; claw-tuft dense, rather longer than claw.

Palpi colour and armature of legs.

Abdomen ovate—somewhat more pointed than male—base squarely truncated; most of dorsal aspect occupied by a pale, brownish fawn-coloured, crenate, lanceolate figure, stained with blue-black; median band extends from anus to anterior fourth, represents a series of about five brown chevrons, of irregular form, apices directed forwards, terminates with a trapezoidal mark. Hairs, coarse black, white, and orange-red, two latter tolerably thick, growing chiefly in angular lines on dorsum; somewhat sparse on lateral margins, which are light brown, shading rapidly into black-brown about border of folium. Vulva brownish-amber colour; slightly elevated, oval; area occupied by involute, convex costæ, enclosing shallow, reddish foveæ, intersected by a rather narrow septum; costæ dilated on superior side of corpus.

Two males and four females of this fine species were contained in *Mr. Alex. Morton's* second collection; they varied somewhat in density of coloration, and in clearness of outline of the specific pattern. Darkest male and lightest female described.

NOTES ON THE USE OF THE SQUARE-SET SYSTEM OF TIMBERING IN MINES AT ZEEHAN AND DUNDAS.

ILLUSTRATED BY A MODEL SQUARE SET.

BY A. J. TAYLOR, F.L.S., F.R.G.S.

ELGIN MARBLES.

BY MONTAGUE RHYS-JONES, C.E.

NOTES ON SOME TASMANIAN INSECTS.

BY A. MORTON, F.L.S.

THE CLIMATE OF EASTERN TASMANIA INDICATED BY ITS LICHEN FLORA.

By Rev. F. R. M. Wilson, Kew, Victoria, Cor. Mem. Roy. Soc., Tasmania.

During a visit of five weeks to Tasmania, in February and March, 1891, while exploring for lichens in the neighbourhoods of Launceston, Mount Arthur, Ulverstone, Hobart, Mount Wellington the Huon River, and St. Mary's Pass, I was struck with the general and unexpected poverty of the lichen flora, and, on looking about for the cause of this, I noted the evident frequency of bush fires, which are the most destructive enemies of lichen growth. This, however, did not wholly explain the matter, for, even where the plants might be expected to recover from the action of the fire, their vitality seemed to be checked by the dryness of the climate. This was a discovery surprising to a Victorian, who had been accustomed to consider the climate of Tasmania a humid one. An examination of meteorological authorities, however, showed that in the eastern portion of the island the rainfall is not only less than it is in the western, but less than it is in Victoria. In the west and the highlands of Tasmania 75in. of rain have been registered in one year, and the average of the whole island is said to be 35in.; but the annual rainfall at Hobart is only 21·52in.

These adverse influences of fire and drought doubtless react on one another, the fires thinning the forests and undergrowth, and thus lessening the rainfall, and the lack of rain exposing the country to the ravages of fire.

These influences, however, are considerably modified in the eastern part of Tasmania by the altitude of the mountains and by the ocean currents along the coast, both of which have a great effect upon the geographical distribution of lichens.

When I visited Tasmania, I was anxious to test a theory which I entertained with regard to the distribution of lichens in Australia. This theory was that the warm current from the tropical Pacific Ocean, passing down the east coast of Australia, carries southward the spores of tropical lichens and the conditions favourable to their growth, until it is met by the cold south-west seas and winds which greet the traveller when doubling Wilson's Promontory from the east. Nautical observations have determined the trend of this coastal current, and traced it from the tropics southward beyond Australia and along the eastern coast of Tasmania.

Nylander tells us (Syn. Meth., p. 69) that the tropical zone is specially characterised by its epiphyllous lichens, notably by the genus *Strigula*, and, among corticole lichens, by the numerous species of *Thelotrema, Graphis, Chiodecton, Glyphis, Trypethelium*, and *Porina*.

These genera, which are allied to the *Ascomycetes* among the Fungi, are largely represented in Queensland, on the eastern or seaward side of the coastal ranges. All of them, except the *Porinæ*, appear along the coast of New South Wales, but are less numerous there, both specifically and individually. In Victoria neither *Strigulæ* nor *Porinæ* have been found unless in a very undeveloped state; and the other genera have far fewer representatives than in the more northern colonies. They are most frequent in the eastern part of Victoria. I discovered many species of *Graphis* and *Thelotrema* and several *Chiodecta* on the seaward slope of the dividing range to the east of Melbourne, and especially on the Gippsland coast, and one *Glyphis* and one *Trypethelium* at the Lakes Entrance in Gippsland.

It remained to be seen whether or not my theory would be supported by lichenological explorations in Eastern and North-eastern Tasmania. I had opportunity to test it on Mt. Arthur and in St. Mary's Pass. And I found some of the same *Graphides* and *Chiodecta* and even a *Trypethelium*, which I had collected near Sydney and at the Lakes Entrance in Victoria. Two or three species of *Chiodecta* I found, not only on Mt. Arthur, but even as far south as Mt. Wellington. The genus *Trypethelium* is especially tropical or sub-tropical. And the presence of one of this genus in St. Mary's Pass testifies to the geniality of the climate in Eastern Tasmania.

As in Victoria, so in the more southern colony, the warm current down the east coast of Australia brings southward conditions favourable to the growth of sub-tropical lichens.

These facts, I think, suggest to the medical faculty what, probably, their experience has already proved, that the climate of East Gippsland, and the eastern coast of Tasmania must be pre-eminently beneficial to invalids. Lichenological observations indicate that both of these places are favoured by a much milder winter, as well as a cooler summer, than the other parts of their respective colonies.

TASMANIAN LICHENS.

BY REV. F. R. M. WILSON.

PART I.

There is no class of plants which ordinary people know or notice so little as lichens. Yet this does not arise from their rarity or the sparseness of their distribution, for they grow almost everywhere on the globe, especially in the temperate and polar zones; and some species are very numerous. For example, the "reindeer moss," as it is called, while it is found in all cool climates, grows in the Arctic regions so profusely that the individual specimens of it are said to greatly outnumber those of any other species of plant throughout the world. The range af altitude and position also is very extensive. Some species are found on Alpine heights where no other vegetation exists; and some grow on the seaside, between high and low water. Some thrive on hard rocks exposed to the noonday sun; and some delight in the shade of caves and forests. The substrata on which they grow are various. Sandy earth, clay and loam, sandstone, granitic, basaltic, and calcareous rocks, dead wood, the bark and leaves of trees, mosses, etc., even dried bones, leather, iron, and glass afford them foothold. But they seem to absorb very little nutriment from any of these substrata; and most of them indeed live wholly on air and moisture. The two great enemies of lichen growth are lengthened droughts and frequent bush fires. From the effects of the latter agency many parts of Tasmania, especially in the eastern half of the island, have been much denuded. It is possible that in the wilder and moister west there may be fuller scope for the adventurous lichenologist. There may be species found there which do not grow in the eastern parts; and the converse will doubtless be found true.

1. THE COLLECTION OF LICHENS is very simple. They are removed by a sharp knife from the bark of trees, or with the bark and a piece of the wood, or by a small cold chisel from dead wood and rocks; and they need merely to be wrapped in soft paper—old newspapers will do—and carried home with just sufficient care to prevent their being bruised or rubbed. Their preservation is also simple. Few of them need any preparation if they are collected in a proper state, neither wet nor too dry. They can be glued down, as they are, on to a slip of paper, on which the date and place of collection should be noted, with the name of the collector.

2. THE EXAMINATION OF LICHENS is a somewhat more difficult matter. Although their anatomical parts are few, and their various organs comparatively simple, these are often so minute as to require the use of a microscope with a good quarter-inch objective. The *apothecium* or fruit is of various forms, but invariably contains *thecæ* or bags which hold the spores. The usual number of spores in each theca is eight. When large they are reduced even to one, and sometimes they are very minute and numerous. The *spermagones* are small nuclei form organs, containing and ejecting the *spermatia*, which are very minute, and are supposed to fructify the apothecia. The *thallus*, or vegetative part of the plant, is either crustaceous or foliaceous. The latter is the typical form, and is generally composed of three strata—cortical, *gonidial*, and medullary—of which the gonidial is specially characteristic.

3. HOW TO KNOW A LICHEN.—If it is desired to know whether a plant is a lichen or not, cut off a minute portion of the thallus and lay it on a glass slip. Moisten it with a drop or two of water, and then bruise it down gently with a penknife till it seems all melted down; put on a small glass cover and submit it to the microscope, as above. If it be a lichen, there will be found small greenish or yellowish cells, with transparent walls, called *gonidia*, or bluish cells without walls, called *gonimic granules*. The latter are sometimes conglomerated in sacs of various sizes and shapes, or concatenated like a necklace, or scattered more or less widely through the substance of the plant. It will be well to try several portions in case the first examination shows none of these cells. Some lichens, however, are nothing but apothecia, and grow on the thallus of other lichens. The class to which these apothecia belong is determined by their general likeness to the apothecia of other lichens.

4. CLASSIFICATION.—This class of plants finds its place between the algæ and the fungi; many obscure plants of the lower forms being with difficulty distinguished from algæ, and many species having so strong an affinity to fungi that it has often been a question whether they do not belong to that class.

The family which bears the closest affinity to the algæ is that of the COLLEMACEÆ, so called from their gelatinous appearance (Greek *colle*, glue) when moistened. Some of these, indeed, which grow on maritime rocks and are washed daily by the tide are very readily mistaken for algæ.

Closely connected with this family are the remarkable MYRIANGIACEÆ (Greek *myrios*, many, *angion*, vessel) of which there are only two or three species known.

The family of LICHENACÆ, or lichens properly so called, includes all the other species, and is divided into six series.

The EPICONIODEI, or dusty fruited series (Greek *epi*, upon, *conia*, dust) are readily distinguished from all the other families by the pulverulent spores on the surface of the apothecium.

The CLADODEI, or shoot-like series (Greek *clados*, a shoot) have peculiarly fungoid apothecia growing mostly on the summit of *podetia*, or stems rising from a foliaceous thallus.

The RAMALODEI, or branch-like series (Latin *ramale*, a branch) have apothecia with a thalline margin, which grow on a generally pendulous thallus.

The PHYLLODEI, or leaf-like series (Greek *phyllon*, a leaf) have their thallus depressed to the substratum, and lobed.

The PLACODEI, or plate-like series (Greek *plax*, a plate) have a crustaceous thallus,

The PYRENODEI, or nut-like series (Greek *pyren*, a nut) are marked by the fructification being in closed receptacles.

5. TASMANIAN LICHENOLOGY.—The lichens of Tasmania have had more attention paid to them than those of Australia. As far back as 1802, Mr. Robert Brown, who accompanied Flinders on his voyage round Australia, collected and named a number of lichens, which have been examined in the light of more modern knowledge and re-named by Rev. Mr. Crombie in a paper given to the Linnæan Society of London (Journ. Linn. Soc., vol. 17 pp. 390-401). Of these 50 are from Tasmania.

In 1839-1843, Mr. Joseph D. Hooker accompanied Sir James Clark Ross in a voyage of discovery to the Antarctic regions, in Her Majesty's ships the *Erebus* and *Terror*. Mr. Hooker was assistant surgeon of the *Erebus* and naturalist of the expedition. Among other places visited was Tasmania. There they found several zealous botanists, who had been inspired by a Mr. Robert Lawrence, and who assisted Hooker in making a botanical collection in the island. On returning to England, Hooker drew up and published in 1847, under authority of the Lord Commissioners of the Admiralty, an account of the botany of the voyage. The third and fourth volumes contain the Flora Tasmaniæ, in which Rev. J. C. Babington and Mr. Mitten describe the lichens, Mr. Mitten undertaking the crustaceous kinds. They enumerate 92 in all, two of them being described as new. The names of the collectors are given: Hooker, Lawrence, Ronald C. Gunn, Charles Stuart, employed by Mr. Gunn, William Archer, of Cheshunt, Dr. Milligan, of Hobarton, Dr. Scott, and A. Oldfield. After Hooker's return to England the lichens sent to him were submitted to Mr. Thomas Taylor, and his determinations were published in the London Journal of Botany, 1844-1847.

A number of specimens were collected subsequently by Charles Stuart for Dr. Ferdinand Müeller, of Melbourne, now Baron Von Müeller, and were transmitted by him to Dr. Hampe, of Germany, in 1850, who published the names and descriptions of 34 in Schleehtendal's Linnæa for 1852, p. 709, etc., under the title of Plantæ Muellerianæ. Another small collection was forwarded long after by Dr. Müeller to Dr. Krempelhuber, of Germany, who published his determinations of 37 species in Den Verhandlungen des Kaiserlich-Koniglichen Zoologisch-botanischen Gessellschafft in Wien, 1880, p. 329, etc. These last have been revised by Prof. Jean Müller, of Geneva, in the Ratisbon Flora, 1887, No. 8.

The lichens determined by Hampe and Krempelhuber are enumerated in the supplements to the 11th volume of the Fragmenta Phytographiæ Australiensis.

Dr. William Nylander, in his synopsis Methodica Lichenum, 1858-1860, describes several Tasmanian lichens not mentioned by others.

Twenty-two species, determined by Prof. J. Müller, are enumerated by Baron Von Müeller in the Victorian Naturalist, October, 1887, p. 89.

6. Herbaria of Tasmanian Lichens are not deposited, so far as I am aware, in any public institution in the colony to which students could refer. I believe that Brown's collection is in the British Museum, Hooker's in the Kew Museum, in England, Nylander's in the Paris Museum, Hampe's among his Lichenes Exsiccati, and Krempelhuber's in his herbarium at Blankenberg. A few Tasmanian specimens will be found also in the Botanical Museum in Melbourne.

There are several collections in private hands. Mr. Augustus Simson, of Launceston, and Mr. W. A. Weymouth, of Hobart, to both of whom I was kindly introduced by Mr. A. Morton, Sec. R.S., T., have made collections of Tasmanian lichens, and generously allowed me to select any specimens from their herbaria. Mr. R. A. Bastow, formerly of Hobart, now of Melbourne, made a considerable collection with the intention of following up his able descriptions of the Mosses and Hepaticas of Tasmania in the Proceedings of the Royal Society of Tasmania, by describing the lichens of the island. It is to be regretted that he is unable to continue his valuable work. In a most generous manner he handed over to me his whole collection, that I might make such use of it as I thought fit. And having myself made a large collection during a late visit to Tasmania, I possess a somewhat extensive herbarium of Tasmanian lichens. I have consulted the lichen herbarium in the Botanical Museum in Melbourne as well as my own in the drawing up of this paper, and also the literature specified above. For the naming of Messrs. Simson's, Bastow's, and Weymouth's specimens I alone am responsible.

7. GEOGRAPHICAL DISTRIBUTION.—In Rev. Mr. Crombie's paper are recorded many of the places where Brown collected his various specimens. These places are scattered over the colonies of Tasmania, Victoria, South Australia, New South Wales, and Queensland. But these divisions were not known to Brown, and are not noted by Crombie. There has been some difficulty in determining the spots. For example, Table Mountain was found to be the name of what is now Mount Wellington in Tasmania, and is not to be confused with Table Mount near Lake Sorell. Derwent River and Risdon Cove were of course readily recognised. Anna Maria River was with some difficulty decided to be a small stream running down to D'Entrecasteaux Channel in Tasmania. On the other hand, Grose River was found in Flinders chart of New South Wales as a tributary of the Hawkesbury. Crombie seems, however, to have considered it a Tasmanian stream, for one of the lichens found by Brown at Grose River is named by Crombie *Ephebe Tasmanica.* Kingstown has not been included in Tasmania, though there is a place on the Derwent called Kingston, because the lichen said to have been found there, *Physcia picta,* is a tropical plant, not found, I believe, either in Tasmania or in Victoria. The Kingstown mentioned by Brown may probably be an island off the coast of Western Australia, 32deg. S., 115·30deg. E.

Hooker, in his Flora Tasmanica, mentions as habitats of lichens "The Springs" on Mount Wellington, Cheshunt, Esk, at Launceston, Macquarie Plains, Richmond, Back River, and Southport. The other publications do not specify the habitats. Mr. Simson collected on the Blue Tier, Mr. Weymouth and friends, and Mr. Bastow and friends collected in Maria Island and Tasman Peninsula, on Mount Wellington and about Hobart, at the Gordon River, and in the neighbourhood of Southport; and myself about Launceston, Mount Arthur, Hobart, Mount Wellington, St. Mary's Pass, the Huon River, and Ulverstone.

CLASS OF LICHENS.

Thallus containing gonidia or granula gonima variously disposed, and also very often crystals of oxalate of lime in the crutaceous species. Fructification consisting of apothecia, containing spores in thecæ. Spermatia in nucleated conceptacles—spermagones—distinct from the apothecia.

The families and their principal divisions are founded on the diversities of the thallus, and sometimes on those of the apothecia, and even of the spermagones.

FAMILY 1. COLLEMACEÆ.

Thallus usually dark in colour, black, brown, or olive, sometimes ashy or bluish, various in form, gelatinous in substance, enclosing granula gonima, which are variously arranged—moniliform, or enclosed in sacs, or dispersed. Apothecia usually rufescent or pale, seldom black, generally lecanorine or biatorine, rarely endocarpoid.

GENUS 1. EPHEBE. Fr. Born, Nyl.

Thallus minute, filiform, branched. Granula gonima large, sub-transversely arranged in heaps; 2, 4, or more together. Apothecia endocarpoid in thickened portions of the thallus, spores 8, colourless.

Species 1, *E. pubescens*, Fr., blackish-brown, slender, cæspitose, entangled, branched, slightly rugulose. Spores lineari-oblong or subfusiform, 1 septate.

Habitat on sub-alpine rocks. Mount Wellington.

2. LICHINA. Ag.

Granula gonima cærulescent. Apothecia terminal in globose thalline receptacles, lecanorine, sub-pyrenoid. Spores ellipsoid, simple.

1. *L. confinis*, Ach., fuscous black, densely cæspitose, small, cylindrical, not compressed.

Hab. on maritime rocks between high and low water. Brown's River, Ulverstone.

3. SYNALISSA, D.R. Nyl.

Thallus small, of various forms—encrusting, sub-membranaceous; granulose or fruticulose. Granula gonima in globular cells. Apothecia innate, with thalline margin, or rarely imbedded in the thallus.

1. *S. cancellata*, Wilson, black, or dark olive, sub-membranaceous, cancellate, minutely atro-granulose, effuse, and encrusting at circumference. Granula gonima light green, enclosed in gelatinous sacs (inky with I.), 1 to 5 in each, also moniliform among fine elementary filaments. Apothecia minute (about ·25 mm. broad), prominent in the thalline granules, one in each, at first endocarpoid, at length rufescent, elevated; disk concave or plane, with thalline margin withdrawn. Spores colourless, ellipsoid or ovoid, simple, with narrow epispore, ·01 to ·012 × ·004 to ·006 mm. Paraphyses slender. Thecæ cylindrical. Gel. hym. I. vinous, then yellow.

Hab. on rocks and moss, S. Esk at Launceston.

4. PYRENOPSIS. Nyl.

Thallus crustaceous granuloso areolate, internally rubricose, laxly cellulose. Granula gonima agglomerated in globular sacs. Apothecia concolorous, minute, urceolate, innate in a prominent marginal receptacle; margin somewhat swollen and connivent. Spores simple.

1 *P. Tasmanica*, Nyl., fuscous black, thin, effuse, subtilely rugulose above, diffracto glomerulose, glomerules equal. Apothecia many in each glomerule, somewhat impressed, often crowded. Spores ellipsoid or sub-globose, ·004 to ·005 × ·0025 to ·003 mm. No distinct paraphyses. Gel. hym. I. cærulescent.

Hab. on granite rocks, St. Patrick's River. Hook. L.J., Bot.: Nyl.

5. COLLEMA. Ach. Nyl.

Thallus various, no distinct cortical layer. Granula gonima moniliform. Apothecia rufescent, with thalline margin. Spores simple or variously septate.

Sub-genus Collema.

Spores more or less ellipsoid.

1. *C. flaccidum*, Ach., dark green, opaque, membranaceous, lobate, lobes large, expanded, flexnose. Apothecia plane, rufescent. Spores ovoid or broadly fusiformi oblong, ·023 to ·028 × ·007 to ·01 mm.

Habitat on woodland rocks. Hook. L.J. Bot.; on bark, Cheshunt, *Archer*, Hook. Fl. Tas.

2. *C. implicatum*, Nyl. Not enumerated in Nyl. Syn. Meth. Hab. by Derwent River, *Brown*, Cr.

3. *C. læve*, Tayl., olivaceous, under surface paler or cinerascent, smooth, rotundo lobate, undulate. Apothecia rufous or fusco rufous, plane, at length convex, with a thin entire thalline margin. Spores fusiformi ellipsoid, ·013 × 004 mm., 3 to 5 septate, and also longitudinally divided. Granula gonima moniliform. Gel. hym. I. blue.

Hab. among mosses on rocks. S. Esk, Launceston; Mount Wellington, *Weymouth*.

4. *C* ——. In Hooker's Fl. Tasm. Babington says:—"Mr. Archer has found at Cheshunt a species of Collema different from any of those described above, but has unluckily preserved only one specimen. It is unknown to us, and may be new. The dull green thallus grows among mosses, has membranous rounded lobes, in a young state resembling *C. crispum*, Schær. (*C. cheilum*, according to Nylander), but after-

wards expanding into a larger frond, which is much sinuated and tomentose beneath, with rather shaggy down, as in *Leptogium saturninum* (to which, however, this cannot belong, not being a Leptogium), and then resembling a young frond of *Stictina fuliginosa.* Apothecia plano concave, dull red, fringed with the minute, crenated thallodal at margin, then convex, emarginate."

Sub-genus Synechoblastus.

Spores narrow or fusiform.

5. *C. nigrescens*, Huds., nigro virescent, thin, membranaceous, sub-monophyllous, orbicular, depressed, rotundo lobate, radiato rugoso plicatulate, naked or granulate, ascending in the centre, depresso adnate at the circumference. Apothecia dark rufous, plane, small, crowded, thalline margin entire. Spores fusiformi cylindrical, pluri-septate, ·034 to ·042 × ·005 mm.

Hab. on old trees by Derwent River, *Brown*, Cr.

6. *C. leucocarpum*, Tayl. *C. nigrescens var. leucocarpum* of Babington, olivaceous, foliaceo membranaceous, 1 to 3 inches diam., smooth, lobate, lobes rotundate, undulate and plicate, margin flexuous. Apothecia often crowded, albo carneous, convex, pruinose, margin entire, at length withdrawn. Spores elongato fusiform, often acuminate at apices, 3 to 5 septate, ·03 to ·05 × 006 to ·01 mm.

Hab. on trees, Derwent River, *Brown*, Cr.; Hook. L. J. Bot.; Circular Head, *Gunn*, Hook. Fl. Tasm.; Krplh.; *Stuart* in herbar. Bot. Mus., Melb.; Mount Wellington, (and *Weymouth)* Brown's River, St. Mary's Pass; Macrobie's Gully, and New Town Falls (*Bastow*). Mr. Crombie says = *C. glaucophthalmum*, Nyl., which is a mistake. Though somewhat alike, they are quite distinct. *C. glaucophthalmum* is frequent in Victoria, but has not yet been found in Tasmania. It is likely, however, to occur associated with *C. nigrescens*.

7. *C. aggregatum*, Ach., *var. thysanæum*, Moug. *C. thysanœum*, of Babington, nigrescent, membranaceous, lobate, plicate, difformed, lobes sometimes crenate, margins often granuloso crispate. Apothecia dark rufous or rufous, moderate, crowded, with thin thalline margin. Spores 8 or 6, fusiformi cylindrical, pluri septate, not rarely somewhat curved, ·033 to ·065 × ·004 to 005 mm.

Hab. on bark, Cheshunt, *Archer*. Hook. Fl. Tasm.

8. *C. quadriloculare*, Wilson, *var. Tasmaniæ*, Wilson, fusco olivaceous or nigricant, membranaceous, adhering, lobate, thicker at circumference, crisped. Apothecia moderate, crowded, black or rufous black, plane, or somewhat concave, with entire thalline margin. Spores cylindrical, rounded at each apex, somewhat curved, 8 locular, ·04 to ·05 × ·003 to

·004 mm. Paraphyses slender, not articulate. Granula gonima moniliform or sometimes conglomerated in fours in gelatinous sac.

Hab. on mosses on sub-alpine rocks, summit of Mount Wellington. Type, with 4 locules in the spore, occurs at summit of Mount Macedon, Victoria.

6. LEPTOGIUM, Ach.

Thallus very various, thin. Granula gonima moniliform. Cortical layer angulari-cellulose, distinct. Apothecia lecanorine or sub-biatorine. Spores 8, colourless, ellipsoid, variously divided.

1. *L. tremelloides*, L., plumbeo glaucescent or plumbeo olivaceous, thin, membranaceous, smooth, lobate, imbricated and crisped. Apothecia rufous or rufescent, elevated, concave or plane, with margin thick, entire, elevated, lead coloured. Spores ellipsoid, acuminate at apices, ·016 × ·006 mm., 3 to 5 septate and longitudinally divided.

Hab. on trees and rocks in shady places, Cheshunt, *Archer*. Hook. Fl. Tasm.; Krplh.; Mount Wellington (and *Weymouth*), Mount Arthur, St. Mary's Pass.

2. *L. tasmanicum*, Wilson, small, plumbeous or fusco rufous, very thin, membranaceous, smooth, rotundo lobate, lobes imbricate, crowded, sub-ascending in centre, sinuate, undulate and crenate, often dentato fimbriate, or sometimes revolute downwards. Apothecia large compared with the thallus (1 to 2 mm. or more broad), rufous, thalline margin, often dentato crenulate. Spores fusiformi ellipsoid, 3 septate, with longitudinal divisions, ·02 × ·01 mm.

Hab. on mossy earth. Brown's River.

3. *L. Victorianum*, Wilson, obscurely plumbeous, beneath sub-cinerascent, large, rotundo lobate, lobes undulate, firm, thickish, confusedly rugulose, Apothecia moderate, rufous, thalline margin thickish or plicate or granulate or laciniolate. Spores ovoideo fusiform, acuminate at apices, 3 septate, with central locules longitudinally divided, ·013 to ·017 × ·005 to ·006 mm.

Hab. among mosses on trees, Mount Wellington, *Weymouth*.

FAMILY 2. MYRIANGIACEÆ.

Thallus black, noduloso pulvinate, cellulose, unstratified. Apothecia sub-lecanorine, sphæroideo cellulose. Spores 8, colourless, oblong, irregularly septate, or almost murali divided.

GENUS 1. MYRIANGIUM. Mnt. and Berk.

Characters above, as there is only one genus in the family.

1. *M. Duriæi*, M. and B., black, opaque, small, tuberculato glomerate or noduloso confluent, often depresso pulvinate. Apothecia small, black, slightly impressed. Spores oblong or oblongo ovoid, variously septate, ·02 to ·036 × ·009 to ·016 mm. Gel. hym. I. vinous.

Hab. on bark of trees, especially on *Acacia decurrens*, S. Esk at Launceston, St. Mary's, Hobart, Mount Wellington (and *Weymouth*), Huon River.

FAMILY 3. LICHENACEÆ.

Thallus various in colour—white, whitish, cinerascent, flavicant, rufous or fuscous, rarely nigrescent; various in form—filamentous, foliaceous, squamose, crustaceous, pulverulent, or evanescent. Apothecia various—stipitate, lecanorine, peltate, patellulate, lirellate or pyrenoid.

SERIES I. EPICONIODEI.

Apothecia with the spores naked, collected into a sporal mass on the surface, Spores 8 in theca.

GENUS 1. CALICIUM. Ach. Nyl.

Thallus filmy, granulose, powdery, squamose, or evanescent. Apothecia minute, black, stipitate or subsessile, capitula globose, or turbinate, or cupular. Spores fuscous or nigricant.

1. *C. phæocephalum*, Bor., *var. albidum*, Wilson, whitish, thin, smooth. Apothecia with slender, black, or fuscous stipe 1·5 mm. high, ·05 mm. thick; capitula obconical, ·2 mm. broad, with citrine powder on margin and beneath, sporal mass umber; spores spherical, diameter ·002 to ·003 mm., dilutely fuscescent, containing a central locule.

Hab. on decorticated decaying eucalyptus, and on stringy bark of growing eucalyptus. Mount Wellington.

2. *C. Victoriæ*, C. Kn., white or whitish or cinerascent, more or less marked, effuse. Apothecia black, ·5 to 1 mm. high, stipe ·1 mm. thick, incrassate towards the base; capitula turbinato lenticular, or hemispherico lenticular, ·25 to ·5 mm. broad. Spores simple, fuscous, or fuscescent, nucleus darker, fusiformi ellipsoid, compressed, ·005 to ·008 × ·002 to ·003 mm., and when viewed from the side ·0015 wide; paries thick, defined by a dark line on the outside.

Hab. on decorticated decaying eucalyptus. Mount Wellington (and *Weymouth*), Mount Arthur.

Var. gracile, Wilson, apothecia somewhat longer and slenderer than type; capitula turbinate and much smaller. Spores smaller and narrower, fusco nigrescent.

Hab. on decorticated decaying eucalyptus, Mount Wellington, S. Esk at Launceston.

3. *C. roseo-albidum*, Wilson, rosy whitish, thick, minutely cancellate, chrysogonimic. Apothecia black, minute, ·7 mm. high; stipe ·06 mm. thick; capitula lenticular, ·2 mm. broad. Spores nigrescent, oblong or oblongo ellipsoid, apices rotundate, uniseptate, ·005 or more × ·002 to ·003 mm.

Hab. on decorticated decaying eucalyptus, Ulverstone.

The thallus often covers a large part of the tree, and when bruised it becomes a deep yellow. It has a faint primrose scent.

4. *C. piperatum*, Wilson, whitish or cinerascent. Apothecia black, sub-sessile, ·2 mm. high; stipe, ·1 mm. thick; capitula lenticular, disk plane ·25 mm. broad. Spores fusco nigricant, oblong, ·004 to ·008 × ·0025 to ·005 mm., uniseptate, generally much constricted at the middle, each cell containing a globular locule.

Hab. on decorticated decaying eucalyptus, Mount Wellington; South Esk at Launceston.

5. *C. quercinum*, Pers. *var. microcarpum*, Wilson; pallid or pallido cinerascent, thin, effuse. Apothecia black, ·5 mm. high; stipe ·13 mm. thick; capitula turbinate, ·2 mm. broad, with a thin whitish margin. Sporal mass black, protruded upwards. Spores fuscous, with reddish epispore and nigrescent nuclei, uniseptate, ·008 × ·003 mm.

Hab. on cortex of growing eucalyptus, Mount Wellington.

6. *C. curtum*, Borr., whitish, thin or evanescent. Apothecia variable in size, to 1·8 mm. high, but often much less, stipe to ·2 mm. thick; capitula turbinate to ·6 mm. broad, albo suffused beneath. Sporal mass black, protruded upwards. Spores nigricant, ellipsoid, uniseptate, ·005 to ·01 × ·002 to ·003 mm.

Hab. on decorticated decaying eucalyptus, Launceston, at foot of Mount Arthur, St. Mary's, Mount Wellington.

7. *C. roscidulum*, Nyl., white, thick. Apothecia ·9 mm. high; stipe ·1 mm. thick; capitula turbinato lenticular, ·4 mm. broad, margin and upper part of stipe golden green. Spores fuscescent, ellipsoid, constricted at middle, uniseptate, ·003 to ·006 × ·002 to ·003 mm.

Hab. on decorticated decaying eucalyptus, Launceston.

8. *C. tricolor*, Wilson, sulphureous, leproso granulose. Apothecia black, to ·75 mm. high; stipe, ·1 mm. thick; capitula

turbinato globose, ·2 to ·5 mm. broad, margin white. Spores fuscous, fusiformi ellipsoid, sub-acuminate at each apex, somewhat constricted in the middle, uniseptate, with a fusco nigrescent locule in each cell, ·008 to ·012 × ·003 to ·005.

Hab. on decorticated decaying eucalyptus at foot of Mount Arthur.

2. TRACHYLIA, Fr., pp. Nyl.

Thallus thin, granulose or sub-leprose or smooth or foreign. Apothecia black, sessile, cupuliform, open; sporal mass black. Spores nigricant or fuscous black, ellipsoid or oblong, uniseptate, rarely pluriseptate.

1. *T. emergens*, Wilson, white or whitish, thin, smooth, somewhat shining. Apothecia seeming to emerge from among the fibres of the wood, and at length barely standing out above the thallus, breadth to ·5 mm. Spores fusco nigricant, adhering closely together, ellipsoid, about ·005 × ·003 mm. but very variable in size; uniseptate, with a locule in each cell.

Hab. on eucalyptus rails in mountainous regions, Mount Wellington (and *Weymouth*), St. Mary's.

3. SPHÆROPHORON.

Thallus cæspitoso fruticulose, ramose and ramulose, smooth, polished, fragile, fertile apices sub-globoso incrassate, enclosing the apothecia, which are nucleiform, enclosed, ultimately exposed by the irregular dehiscence of the thalline covering. Spores nigricant or violaceo nigricant, spherical or subglobose.

1. *S. compressum*, Ach., pallido albicant or lurid, ramose, plano compressed. Apothecia obliquely innate on the apices, receptacle wrinkled, at length lacero dehiscent or discoid and open. Spores nigricant, spherical, ·007 to ·011 mm.

Hab. on trees in mountains, Krplh.; on *fagus*, *Gunn*,. Hook. Fl. Tasm. Blue Tier, *Simson*; Tasman Peninsula, Mount Bischoff and Mount Faulkner, *Weymouth*; Gordon River, *Allport*; Maria Island, *Bastow*; Mount Arthur, Mount Wellington.

2. *S. Australe*, Laur.; glauco pallid, sometimes lurid, under surface albicant, rugose, to two inches long, branches explanate, often distichously ramulose. Receptacle 6 to 12 mm. broad, lenticulari compressed, external margin at apex cristato crenate and sometimes proliferous. Spores ·011 to ·015 mm.

Hab. on trees in mountains, *Brown*, Cr.; Cheshunt, *Archer*, on *fagus*, *Gunn*, Hook. Fl. Tasm. Mount Wellington, (and *Weymouth*); Mount Arthur, Ulverstone.

3. *S. coralloides*, Pers., pallid or whitish, sometimes lurid, ramulose, terete. Apothecia in globose receptacles irregularly dehiscent above, 2 mm. or more in diameter. Spores ·009 to ·015 mm.

Hab. in mountainous regions on stones and trunks of trees, *Brown*, Cr.; Cheshunt, *Archer*, Hook. Fl. Tasm.; Nyl.; Krplh.; Mount Wellington (and *Weymouth*), Mount Arthur.

4. *S. tenerum*, Laur., pallid or white, terete, much branched, slender, 2 to 3 inches high, with filiform intricate branches. Apothecia 1 to 2 mm. diam., on primary branches or axes, soon denuded of thalline receptacle, which is persistent at margin of base. Spores nigricant, ·007 to ·008. mm.

Hab. on trees and earth on mountains, Cheshunt, *Archer*, on *Fagus*, St. Patrick River, *Gunn*, Hook. Fl. Tasm.; Krplh; Tasman Peninsula, *Weymouth*, Mount Arthur, Mount Wellington.

SERIES II. CLADODEI.

Thallus generally erect. Apothecia terminal on podetia, rarely sessile on thallus, biatorine, rarely lecanorine. Spores 8, colourless, usually oblong and simple, sometimes elongate and septate.

GENUS I. GOMPHILLUS, Nyl., Wilson.

Thallus very thin, consisting of gonidia and filaments irregularly conglutinated. Apothecia small, stipitate by constriction of the hypothecium, of a most tenacious, horny texture. Spores 8, filiform, very long, multiseptate, in cylindrical thecæ. Paraphyse, not discrete.

1. *G. bæomyceoides*, Wilson = Patellaria Wilsoni, Müll., Arg., Lich., Beit. 1435, cinereous or virescent, effuse, very thin and somewhat shining, or thicker and eroso isidioso granulate. Gonidia various in form and size, conglomerated into gelatinous sacs. Apothecia of tenacious, horny texture, biatorine, sometimes margined by the white hypothecium, scattered or conglomerated, depresso globose, to 1·15 mm, diam., smooth, rufo fulvescent, pale when young and dark in age, sub-sessile or stipitate, stipe to ·5 mm. high and ·5 mm. thick, with sometimes 2 or 3 capitula on one stipe. Spores 8 in cylindrical thecæ, aciculari filiform, about ·14 mm. long, pluriseptate.

Hab. on roots and trunks of trees, on mosses and bark, on jungermannia and lichens, also on dead leaves, etc., on the earth, Mount Arthur.

2. BÆOMYCES, Pers.

Thallus crustaceous, powdery, granulose, or squamulose. Apothecia biatorine, sessile or stipitate.

1. *B. roseus*, Pers., *var. fungoides*, Ach., whitish, granulose, margin of granules spreading, thin, continuous (K. faint yellow). Apothecia roseo carneous or albo carneous, subglobose or globoso clavate or deformi clavate, 2 to 4 mm. broad (K. orange). Stipe 4 to 8 mm. long, whiter, subterete. Spores oblong or fusiform, simple, ·011 to ·023 × ·0035 mm. Paraphyses slender.

Hab. on earth (chiefly clay) in mountainous regions. Hook. Fl. Tasm.; Mount Wellington (and *Bastow* and *Weymouth*).

2. *B. heteromorphus*, Nyl., pallido glaucescent or pallido cinerascent, verrucoso unequal, forming large patches. Apothecia pale carneous or carneo fuscescent, ·5 to 1 mm. high, variously compressed or plicate, often 2 to 6 or more conglomerated on one stipe. Spores very transparent, ellipsoid, simple, ·01 × ·006 mm. (Thal. and Ap. K. + C.—).

Hab. on clay, mosses, dead leaves, etc., in mountainous regions, *Oldfield*, *Gunn*, Cheshunt, *Archer*, Hook Fl. Tasm.; Nyl.; Tasman Peninsula and St. Crispin's (and *Weymouth*), Mount Wellington (and *Bastow*) ; Ulverstone.

3. *B. squamarioides*, Nyl. = *Parmelia splachnirima*, Tayl. = *Placodium splachnirimum*, Tayl. = *Bæomyces splachnirimus*, Mitten = *Knightiella leucocarpum*, Müll. Arg. = *Knightiella squamarioides*, Müll. Arg., albo or albido glaucescent, subopaque, squamose, squamæ difformed, about ·5 mm. broad, affixed, forming small patches about 1 inch wide, lobate or lobato incised, plane or somewhat depressed in the centre, concolourous beneath or whiter. Apothecia lurid or pale lurid or lurido carneous, ·2 to ·3 mm. broad, biatorine, plane, margin thickish, evanescent. Spores oblong or ellipsoid or fusiform, uniseptate or simple.

Hab. on earth among lesser jungermanniæ, *Gunn*, *Stuart*, Hook. L.J. Bot.; Hook. Fl. Tasm.; Nyl.

3. Cladonia.

Thallus foliaceous, laciniiform, with podetia generally dilated at apex into scyphi, and generally foliolose or squamulose at the base, or thallus sometimes granuloso crustaceous. Apothecia variously coloured, seldom nigricant. Spores small, oblong.

Subgenus Cladonia.

Thallus foliaceous or squamose.

I. Apothecia fuscous or fuscescent.

A. Scyphophorus.

1. *C. alcicornis*, Flk., macrophylline, spreading, bluish grey or yellowish green above, white or whitish beneath, laciniæ

narrow, palmato multifid, inciso crenulate at apex, margins with black fibres. Podetia springing from upper surface of laciniæ, margins of scyphi cristate. Apothecia rufescent.

Hab. on dry heathy ground, *Stuart*, Hampe. Doubtful.

2. *C. ceratophylla*, Sw., pale glaucescent or flavido pallescent, laciniose, laciniæ profoundly divided, margin undulate or crenato incised, albid beneath. Podetia attenuate, often subulate and sterile, decorticate, white or whitish, springing from the laciniæ, scyphi narrow or scarcely any. Apothecia pallescent or sub-fuscous. Spores not seen. This plant is smaller than *C. alcicornis* and is like a large-leaved *C. fimbriata*.

Hab. B.v. m. Vic. Nat. Oct., 1887.

3. *C. pyxidata*, Fr., squamulose, ashy green. Podetia cartilaginous, corticate, verrucose, or coarsely granulato pulveraceous or scaly downwards. Scyphi cyathiform, more or less proliferous.

Hab. on earth, *Gunn*, *Oldfield*, Hook. Fl. Tasm.; *Stuart*, Hampe; *Simson*; New Town Falls and Huon-road and Launceston, *Bastow*; Mount Arthur, Mount Wellington, Brown's River; Port Arthur, *Weymouth*.

Var. 1. *pityrea*, Ach., podetia pulverulento granuloso furfuraceous, ashy white, smooth and decorticate and often ribbed or laciniose in the upper part.

Hab. Brown's River, Mount Wellington, Lilydale, Mount Arthur; Launceston, and New Town Falls, *Bastow*; Port Arthur, *Weymouth*.

Var. 2, *chlorophæa*, Flk., podetia pulverulent, granules coarser at the base, sulphury yellow.

Hab. Mount Wellington.

Var. 3, *fimbriata*, Hffm., thallus white, squamulose, podetia membranaceo corticate, deliquescing into a fine impalpable white powder, sometimes scaly from the base upwards.

Hab. Asbestos Hills, *Gunn*, Mount Wellington, *Oldfield*, Southport, *Stuart*, Hook. Fl. Tasm.; Krplhb.; Mount Wellington and New Town Falls and Launceston and Huon-road, *Bastow*.

This variety occurs in Tasmania under the following forms:—

F. radiata, Schreb., podetia irregularly scyphophorous and radiato fimbriate, with divided margin, or podetia simple, cornute.

F. antilopæa, Duby; podetia extended, slender, tapering upwards, and arcuate, with minute scyphi.

F. costata, Flk., podetia granuloso pulverulent, at length denuded, and discovering their costate substance; *Wilson* and *Bastow*.

F. longipes, Mount Wellington, *Oldfield*, Hook. Fl. Tasm.

F. coniocræa, Duby, Southport, *Stuart*, Hook. Fl. Tasm.

3. *C. cariosa*, Ach., thallus pale ashy green, scales minute, more or less investing the base of the podetia. Podetia whitish, half to one inch high, dilated upwards, carious, cancellato or eroso lacunose, granulato verrucose, scyphi digitato partite, fastigiate.

Hab. on earth, Nyl., Mount Wellington.

4. *C. gracilis*, Hffm. = *Cenomyce gracilis* of Taylor; thallus pale ashy green or livid brown, leaflets at the base often evanescent. Podetia elongate, filiform, subulate, or scyphophorous and proliferous, corticate, glabrous. Apothecia pedicellate or sessile, fuscous.

Hab. on earth. Hook. L. J. Bot. (Mount Wellington and *Bastow*).

5. *C. verticellata*, Flk. = *Cenomyce allotropa, var. verticellata* of Taylor; thallus foliaceo squamulose, leaflets laciniæform, crenato incised. Podetia ashy grey, corticate, glabrous or sub-verrucose, scyphophorous, scyphi denticulate at the margins, two to four times verticellato proliferous and scyphophorous from centre of scyphi. Apothecia fuscous.

Hab. on earth and among rocks, Hook., L.J. Bot.; Mount Wellington (and *Hooker*, Hook. Fl. Tasm.; and *Bastow*); Port Arthur, *Weymouth*.

6. *C. degenerans*, Flk., thallus squamulose. Podetia whitish or brown, cartilaginous, glabrous, nigrescent and albo guttate at base, scyphophorous, scyphi proliferous, cristato ramose.

Hab. on earth and among rocks, Cheshunt, *Archer*, Hook. Fl. Tasm.; Mount Wellington, Ulverstone.

7. *C. cervicornis*, Schær., thallus macrophylline, cæspitose, sub-erect, narrowly laciniato multifid, crenate, cartilaginous, glaucous green above, white beneath, purplish black at base. Podetia from disk of laciniæ, short, slender, smooth, or sub-verrucose, scyphi simple and leafless, or irregularly proliferous, and more or less squamose.

Var. stipata, Nyl., basal squamæ elongate, sub-linear, crenato incised, erect, stipate, rarely fertile.

Hab. on hills and rocks, *Stuart*, Hampe; Krplh.; Mount Wellington, Huon-road.

8. *C. decorticata (?)* Fr., thallus squamose or squamulose, glaucous above, white beneath, or sometimes nigricant, lobate and crenate. Podetia one or two inches long, cylindrical,

nearly all rough, with squamules ascyphous, or with narrow scyphi. Apothecia fuscous, often confluent.

Hab. among mosses in rocky places, Mount Wellington, *Oldfield*, Hook. Fl. Tasm.; *Coates*. Marked doubtful as above in Fl. Tasm.

9. *C. cornuta*, L. = *C. fimbriata, var. cornuta* of Babington, thallus pale ashy green, or livid brown at the base, sparsely foliolose, folioles lobate, crenate, or none. Podetia 2 to 4 inches long, upwards to beyond the middle glabrous, at the apex pulverulent, generally cornute, a few scyphophorous, scyphi narrow, often irregular, and sometimes sub-radiate. Apothecia fuscous.

Hab. on earth, Mount Wellington and Southport, *Stuart*, Hook. Fl. Tasm.

10. *C. ochrochlora*, Flk., similar to *cornuta*, but often more foliolose. Podetia glabrous, the upper half white or ochrey-white, pulverulent, apex obtuse or narrowly scyphophorous, dentato radiate at the margin, scyphi often glabrous in the cavity and at the base of the teeth, margin green.

Hab. on turfy earth and rotten trunks of trees, Mount Wellington (and *Weymouth*), Mount Arthur, Ulverstone.

B. Ascyphous.

11. *C. furcata*, Hffm., = *Cenomyce ecmocyna, var. subulata* of Taylor; thallus squamulose, evanescent, podetia elongate, pale whitish or brownish green, fruticose, glabrous, branched, branches attenuato subulate, divergenti furcate; apothecia small, fuscous.

Hab. on earth, chiefly on mountains, Launceston, *Gunn*, Mount Wellington; *Oldfield*, Hook. Fl. Tasm.; Krplh.; Mount Wellington, Knocklofty, Mount Arthur; Blue Tier, *Simson*; New Town Falls and Launceston, *Bastow*. Tasmania possesses many forms of this species, some slender, and others inflated. The most marked varieties are as follow :—

Var. 1, *adspersa*, Flk., podetia elongate, squamoso furfuraceous, sparingly branched, branches sub-simple.

Hab. Mount Wellington (and *Brown*, Cr.).

Var. 2, *squamulosa*, Mull. Arg., podetia leafy or scaly.

Hab. Mount Wellington, Mount Arthur, Tasman Peninsula (*Weymouth*).

Var. 3, *polyphylla*, Flk., podetia more or less covered with tolerably large leaflets.

Hab. Mount Wellington.

Var. 4, *attenuata*, Hffm., = *C. acuminata*, Ach. of Crombie, podetia broader, subulato rumose, branches furcate, podetia often partly decorticate.

Hab. Mount Wellington, *Brown*, Cr.

12. *C. coniodendroides*, Wilson; thallus of small pale squamules investing the base of the podetia. Podetia elongated dichotomously, divergenti furcate, with branches and ramules generally at right angles to each other, sometimes irregularly clavate or contorted and swollen, or simple and subulate, wholly covered with whitish or cinereo virescent powder. Apothecia rare, pale fuscescent.

Hab. on earth. Mount Wellington, Ulverstone; Kermandie Valley, *Bastow*. Possibly a variety of *C. furcata*. There is almost complete atrophy of the cortical layer of the podetia, leaving only a few scattered squamules, and often atrophy also of the gonidial layer, leaving only the chrondroid medulla, clothed more or less with whitish powder.

13. *C. cenotea*, Ach. = *C. brachiata*, Fr. of Hampe; thallus almost leafless, or with a few lobato crenate squamules at the base of the podetia, which are cylindrical, whitish, or cinerascent, pulverulent, axils and apices dilated, scyphoid, perforated, the margins of the apertures denticulate, and generally proliferous, the podetia then ramose, repeatedly proliferous, the apertures generally fuscescent within, apothecia pallescent or fuscous.

Hab. on trunks of trees, among mosses, *Stuart*, Hampe.

14. *C. squamosa*, Hffm., = *Cenomyce sparassa*, Ach. of Taylor and Hampe; thallus squamulose, podetia cæspitose, whitish green, cylindrical, two inches high, erect, repeatedly branched, proliferously denticulate, or subulate from margins of the minute irregular scyphi, apices rigid, sub-corymbose, radiato cristate, glabrous, longitudinally sub-lacunose, cortex entire, clothed with minute leaflets or scales, apothecia clustered, fuscous.

Hab. Cheshunt, &c., *Gunn*, *Hooker*, *Oldfield*, *Lyall*, Hook. L.J., Bot.; Hook. Fl. Tasm.; *Stuart*, Hampe; Krplhb.; Mount Wellington, *Brown*, Cr.

15. *C. delicata*, Flk., *var. subsquamasa*, Nyl. Thallus squamulose, white or cinereous; podetia whitish, slender, 1 to 2 inches high, partially glabrous, cartilaginous, longitudinally ribbed or fissured, clothed at intervals at the base with spreading, incised, and crenate scales, granulate in the upper part, branched, radiato cristate, subcorymbose; K + C —.

Hab. on decaying logs and trunks of trees. Mount Wellington; New Town Falls, *Bastow*.

16. *C. capitellata*, = *Cenomyce capillata*, Tayl., = *C. amaurocrea*, *var. capitellata* of Nyl., thallus sparingly foliolose at the base of the podetia, and occasionally throughout; podetia straw-coloured or pallid, slender, smooth, rigid, dichotomously branched, dilated here and there as if with scyphi, which are

open and subradiately proliferous, ultimate ramuli infuscate at apices, with one to four fuscous points. Apothecia shortly stipitate, brown, margin reflexed.

Hab. on rocks and earth, St. Patrick's, Hook. Fl. Tasm.; Mount Wellington, Knocklofty, Mount Arthur; S. Esk at Launceston, and Maria Island, *Bastow.*

II. *Apothecia red.*

17. *C cornucopioides*, L., albido flavescent or cinereo virescent, squamose or squamulose, squamæ lobiform, crenate or crenato incised; podetia glabrous, often granuloso unequal or squamuloso exasperate, $\frac{1}{2}$in. to 1in. high, scyphophorous, scyphi regular, sometimes proliferous. Apothecia bright scarlet, sessile or podicellate on margin of scyphi, often confluent.

Hab. *Laurence*, Asbestos Hills, *Gunn*, Mount Wellington, *Oldfield*, Hook. Fl. Tasm.; Krplh. revis., Mull., Arg.; Mount Wellington (and *Bastow*).

Var. Tasmanica, Wilson, = *C. deformis, var. Tasmanica*, Krplhb. = *C. cornucopioides* Mull., Arg. Flora, 1887, No. 8; thallus foliaceous or evanescent, folioles sometimes large, lobate and crenate or laciniate, variously divided, podetia cyathiform or ascyphous, extended, sometimes proliferous or branched, lower half verucoso corticate, generally squamulose, upper half covered with depressed granules; the podetia, folioles and squamules at first light green, gradually growing fusco flavid upwards, especially at the base of the podetia and the under-surface of the folioles, the upper part of the podetium becoming a deep yellow. Apothecia conglomerate on margin of scyphus or apex of podetium.

Hab. on earth, fern trees, and decaying logs. Krplhb. in hb. Melb. Bot. Mus. (with name and description in his writing); Mount Wellington (and *Bastow*).

F. arrosa, Wilson, podetia truncated, the margin of the scyphi thickened so as to reduce the mouth almost to a point. Apothecia minute.

Hab. on decayed logs, Mount Wellington.

F. sub-macilenta, Wilson, differs from *C. macilenta* in the base of the podetia and the folioles being flavid.

Hab. on decaying logs, Mount Wellington, Ulverstone. Similar to Nylander's *C. angustata*, which, however, has virescent squamæ and sulphureous podetia.

18. *C. intermedia*, Krplhb. *Dr. Story* in hb., Melb. Bot. Mus.

19. *C. deformis*, Hffm., podetia sulphureous, pulverulent, folioles at base pallide virescent, incised, crenate, beneath

whitish or pallescent, scyphi simple, regular, or deformed. Apothecia bright red, discrete, or conglomerate.

Hab. *Oldfield*, Hook. Fl. .Tasm.; Nyl.; Krplhb.; **Mount** Wellington, *Brown*, Cr.

It may be questioned whether the Tasmanian specimens thus named are not *C. cornucopioides, var. Tasmanica,* which is a very polymorphous variety as found in Victoria.

20. *C. Flœrkeana*, Fr., squamules at the base of the podetia crenato incised or crenate, few or evanescent; podetia white, 1 to 1½ inch high, corticate, smooth, obtuse at apex, often obsoletely scyphophorous or incrassate, or briefly divided. Apothecia often conglomerate.

Hab. Falls of the Meander, Western Mountains, *Archer*, Hook. Fl. Tasm.; Krplhb.

21. *C. digitata*, Hffm., thallus of folioles, pallide virescent, crenato incised, or lobate and crenate, underneath white or albid, and there generally pulverulent podetia albido; pulverulent, without folioles, cylindrical, 1 to 2 inches high, simple or rarely divided at the apex, scyphophorous, scyphi with margin either denticulate, or sub-inflexed, or variously divided, and digitato proliferous. Apothecia bright scarlet, small, or confluent.

Hab. Cheshunt, *Archer*, Hook. Fl. Tasm.

Var. macilenta, Hffm. = *C. macilenta* of Babington, thallus smaller or squamulose, podetia ½ to 1 inch or a little more, slender, simple, or shortly divided at the apex, ascyphous, obtuse, rarely with narrow, irregular scyphi. Apothecia confluent.

Hab. Cheshunt, *Archer*, Hook. Fl. Tasm.; Krplhb.

F. seductrix, Del., folioles more evolved, virescent, multifid, crenate; podetia narrow, cylindrical, simple. Apothecia minute.

Hab. on earth. Brown's River, *Oldfield*, Hook. Fl. Tasm.; Nyl.

Sub-genus Cladina, Nyl.

Thallus leafless, podetia without scyphi, repeatedly branched, more or less smooth. Apothecia terminal.

22. *C. rangiferina*, Hffm., cinerascent, 2 to 6 inches high, verruculoso, scabrous, sub-tomentose, terminal branches subcorymbose, fastigiate, apices sub-secund, nodding, K + C —.

Hab. on earth. Hook. L. J. Bot.; *Cunningham*, *Gunn*, etc., Hook. Fl. Tasm.

Var. Sylvatica, Hffm., pale or straw coloured, glabrous, terminal branches radiato cymose, fastigiate, apices sub-secund, nodding, K f y C +.

Hab. on earth, Asbestos Hills, *Gunn*, Hook. Fl. Tasm.; Mount Wellington (and *Brown*, Cr.); George Town and Macrobie's Gully, and Leven River, and Oyster Cove, and Tasman Peninsula, and Maria Island, and Macquarie Harbour, *Bastow*; Port Arthur, *Weymouth*.

F. alpestris, L., white or pale straw coloured, verrucose, intertwining, and divaricately branched, densely thyrsoid at apex, more stipitate below.
Hab. on earth. Cascades and Port Arthur, *Oldfield*, Hook. Fl. Tasm.; Mount Wellington.

F. pycnoclada, Pers., white or yellow, opaque, not glabrous, cæspitose, densely ramose, byssino context.
Hab. Mount Wellington, Ulverstone.

23. *C. uncialis*, Hffm. = *Cenomyce uncialis*, Tayl., greenish straw coloured, glabrous, cylindrical, fistulose, dichotomous, branches short, apices subulate, denticulate or digitate, K — C +.
Hab. on mossy earth, Hook. L. J. Bot.; *Stuart*, Hmpe.
Possibly the specimens have been juvenile forms of *C. capitellata*.

Sub-genus Clathrina, Wainio.

Thallus efoliolose; podetia terebrate or hiascent. Apothecia usually nigricant.

24. *C. aggregata*, Eschw. = *Dufourea collodes*, Tayl., = *Cornicularia terebrata*, Hmpe., pale cinerascent or cervine, pallid or pale, chestnut-red or darker, at base fuscescent, glabrous, somewhat shining, more or less terebrate, sterile branches usually slender and alternato ramulose, with furcate apices, fertile branches thick with shorter turgescent ramules. Apothecia fuscous black or fuscescent, aggregated.
Hab. on earth, rocks, logs, and trees, abundant; all collectors, Hook. Fl. Tasm.; *Stuart*, Hmpe.; Krplh.; Mount Wellington, Mount Arthur, Ulverstone, Brown's River; Knocklofty, and Macrobie's Gully, and Cascades and New Town Falls, *Bastow*.

Var. inflata, Wilson, branches and ramules much inflated, to 3 mm., diam, cylindrical, but broader at furcations sterile.
Hab. on earth and rocks, South Esk at Launceston; and Maria Island, *Bastow*.

Var. 2, *tenera*, Wilson, sterile branches and ramules pale, filiform, intricate, procumbent, K + C —, fertile branches glaucous green, thicker, more terebrate, erect, short, and discrete. K + C +.
Hab. on logs and trunks of trees, common. Mount Wellington, etc.; Tasman Peninsula, *Weymouth*.

25. *C. retipora*, Labil., = *Cenomyce retipora*, Tayl., whitish or bluish white, cæspitose, glabrous, reticulato terebrate or lace-like, thick, branches dichotomous, short, turgid, apices obtuse. Apothecia fusco rufous, or pallescent, or nigricant.

Hab. on earth, Hook. L. J. Bot.; abundant, all collectors, Hook. Fl. Tasm.; *Stuart*, Hmpe.; Nyl.; Krplh.; Ulverstone; George Town, and Southport, and Macquarie Harbour, and Knocklofty, *Bastow*; Tasman Peninsula and Huon, *Weymouth*.

26. *C. schizopora*, Nyl., thallus of whitish or cinerascent or fuscescent squamulæ, which are often much divided or isidioso dissected or furfuraceous; podetia small, 5 to 10 mm., high, pale or fusco rufescent, glabrous, lacunose, and hiascent; much thicker upwards, and usually divided into short branches, which are all truncate and fertile. Apothecia nigricant, minute, aggregate, margined, concave when young, plane when older.

Hab. on rotten logs and trees, Nyl., ex. hb. Hook.; Ulverstone; Tasman Peninsula, *Weymouth*.

4. STEREOCAULON.

Thallus of podetia covered more or less with fragile granules of various forms. Apothecia terminal or lateral, lecideine, fuscous or fusco pallescent, internally solid. Cephalodia of various forms and colours.

1. *S. ramulosum*, Ach., thallus more or less erect, cæspitose, 3 to 5 inches high, strong, elongato ramose, the axis more or less arachnoideo tomentose, branches with whitish fibrillose granules simple or divided and divaricato ramulose. Cephalodia sub-podicellate, scrobiculato unequal, somewhat discoloured, with a gonimic stratum formed of nodules containing gonimic granules. Apothecia fuscous or pallescent, terminal, biatorine, 1 to 2 mm., broad. Spores cylindraceo fusiform, 3 to 7 septate, ·035 to ·06 × ·004 to ·006 mm.

Hab. on rocks, stones, and earth, Hook. L. J. Bot.; *Gunn and other collectors*, Hook. Fl. Tasm.; *Stuart*, Hmpe.; Krplh.; Mount Wellington, *Brown*, Cr. Prof. Mueller says Krempelhueber's specimens belong to the next species. It is probable that the others do so too.

2. *S. proximum*, Nyl., similar to *S. ramulosum*, differing in the cephalodia, in which the gonimic stratum is sirosiphoid. Spores 3 to 5 septate, ·028 to ·06 × ·004 to ·005 mm.

Hab. on rocks and earth in mountainous regions, Krplh. revis., Mull. Arg.; Mount Wellington (*Weymouth* and *Bastow*), Mount Arthur, S. Esk (Launceston), Ulverstone.

3. *S. macrocarpoides*, Nyl., podetia erect, ramulose, 1½ to 3 inches, glabrous, or for most part corticate, granules papillar,

scattered or evanescent, ramules fibrilloso divided. Cephalodia with sirosiphoid gonimic stratum. Apothecia large, 2 to 4 mm. broad, spores 3 to 7 septate, ·036 to ·058 × ·004 to ·006 mm.

Hab. on stones. Nyl. ex hb. Hook.

4. *S. coralloides*, Fr., = *S. Corallinum* of Babington, cæspitose, ramose, glabrous, granules cinerascent, sub-fibrillose, or digitato divided. Apothecia terminal and lateral. Spores cylindraceo fusiform, 3 septate, ·02 to ·04 × ·0025 to ·005 mm. Cephalodia cinerascent, verrucose, minutely granulate, sessile.

Hab. on rocks, St. Patrick's River, *Gunn*, Hook. Fl. Tasm.

5. *S. denudatum*, Flk., podetia slender, simple or branched, attenuate at apex, glabrous, granules whitish or albo cinerascent, sub-peltate, medio depressed, the centre virescent, margin white, crenulate. Apothecia fuscous, small, plane or convex, terminal or lateral, spores elongato fusiform, 3 rarely to 5 and 7 septate, ·02 to ·046 × ·002 to ·004 mm. Cephalodia olivaceo fuscescent, verrucoso glomerulose.

Hab. on rocks and stones, Cheshunt, *Archer*, Hook. Fl. Tasm.

6. *S. leptaleum*, Nyl., thallus small, 5 to 10 mm. high, erect or ascending stipate, sparingly ramose, slender, axis nude, glabrous above or granulose at apices of branches, granules few, white or whitish, sub-globose, small, or pulveraceous. Apothecia not seen. Cephalodia olivaceous, opaque, or olivaceo cinerascent, verrucoso glomerulose, or botyroideo glomerate, gonimic granules disposed in oblong or elongated nodules.

Hab. on granite stones, Nyl.; Mt. Wellington.

7. *S. gracilescens*, Nyl., white or albo cinerascent, of soft habit, with podetia nearly an inch high, cæspitoso congested and intricate, branched in the upper part, sparsely glomerulose, granulose, axis slender, filiform, somewhat glabrous, granules verruculose or nearly pulverulent. Apothecia and cephalodia not seen.

Hab. on granite rocks. St. Patrick's River, *Gunn*, Hook. Fl. Tasm.

SERIES III.—RAMALODEI.

Thallus fruticulose or filamentose, erect or pendulous, terete or variously compressed or angulose, without any folioles or granules or basal crust, internally tubulose with hollow medulla, or solid. Apothecia generally lecanorine.

GENUS I.—SIPHULA, Fr.

Thallus of terete or compressed stipes, erect, firm, simple or often dichotomously divided or ramose, apices obtuse or sub-obtuse, whitish, opaque or sub-opaque, rarely dilated or lobate, medulla white, dense, composed of elementary filaments closely arranged longitudinally. Apothecia unknown.

1. *S. torulosa*, Thunb., white, compressed, smooth, ramose, branches ascending, ramulose, torulose, often thrust down at the obtuse apices and rugose, aggregated into a bushy cushion about an inch high.
Hab. among mosses, Mount Wellington (and *Brown*, Cr.); Ben Lomond, *Bastow*.

2. *S. pteruloides*, Nyl., cæspitose, 1 to 2 inches high, whitish, opaque, upwards compressed and attenuate towards apex, often slightly canaliculate or plicatule longitudinally on both sides, dichotomous or dichotomously ramose, one branch generally the longer.
Hab. among mosses, Mount Wellington.

2. THAMNOLIA. Ach.

Thallus consisting of podetia, which are cylindrical or subcompressed, cornute, imperforate, simple or branched, apices acute, internally fistulose. Apothecia unknown.

1. *T. vermicularis*, Sw., chalk white or whitish, 2 to 4 inches long, prostrate or ascending or erect, simple or rarely bifurcate, smooth or longitudinally rugulose, nearly dispersed, or densely stipate.
Hab. on mossy earth or among *Cladonias*, especially *C. capitellata*, in alpine places, Mount Wellington (and *Brown*, Cr.).

3. USNEA, Dill. Ach.

Thallus fruticulose, filamentose, erect or pendulous, fibrilloso ramulose, medullary axis solid. Apothecia concolorous, orbicular or peltate, terminal or lateral. Spores small, ellipsoid, colourless, simple.

1. *U. barbata*, L. Fr., albido glaucescent or pale cinereo virescent, terete, variously branched, erect or pendulous. Apothecia concolorous, rather large, fibrilloso radiate.
Hab. on trees, logs, and old rails nearly everywhere; Hook. L. J. Bot. and Fl. Tasm.; Krplh.; Wilson; *Bastow*.

F. 1. *florida*, L. Fr., erect, scabrid, divergenti ramose. Apothecia large, plane, pallido carneous, pruinose, with long ciliæ on the margin.
Hab. on trees and rails, common. Hab. Hook. L. J. Bot.; *Stuart*, Hmpe; Wilson.

F. 2, *scabrida*, Tayl. (Müll. Arg.) = *U. scabrida* of Taylor, short, branches few but covered with long fibrils. Apothecia large, disk glaucous or sub-cæsio albid, receptacle more or less ciliate. Spores broadly ellipsoid, ·01 to ·012 mm. long.

Hab. Hook. Fl. Tasm.

F. 3, *hirta*, L. Fr., erect, minutely and abundantly fibrillose, much branched, often only verrucoso sorediate.

Hab. on trees and rails; common.

F. 4, *dasypoga*, Ach. Fr., elongato pendulous, clothed with numerous short spreading fibrils.

Hab. on trees; common. St. Mary's Pass, Mount Arthur, etc.

F. 5, *dasypogoides*, Mull., Arg., pendulous, shorter and more bushy than *dasypoga.*

Hab. on trees; common. Tasman Peninsula, *Weymouth;* Wilson.

F. 6, *articulata*, Hudson, pendulous, elongato ramose, smooth, articulato constricted, more or less inflated.

Hab. on trees; frequent. Mount Wellington, etc.

2. *U. straminea*, Mull. Arg., B. v. M. Vic. Nat., 1887, Oct., p. 89.

3. *U. trichodea*, Ach., albido flavescent or white, glabrous, ramoso intricate, branches sparsely fibrillose, fibrils sometimes sub-secund. Apothecia concolorous, margin nude.

Hab. on trees. Springs and St. Crispin's Well, Mount Wellington, Mount Arthur. Tuckerman says:—*U. trichodea* and *U. longissima* are distinguished from the filamentous forms of *U. barbata* by their always epapillate thallus.

4. *U. longissima*, Ach., flavescent or albido cinerascent, slender, elongato pendulous or very long, terete or compressed, sub-pulveraceous on surface, with few long branches covered with long glabrous fibrils. Apothecia nearly concolorous or pallid, or very thinly glaucescenti suffused, terminal on ramules, margin fibrilloso ciliate.

Hab. on trees, Krplh. Perhaps the specimens found belong to the next species.

5. *U. angulata*, Ach., albido cinerascent, or albido flavescent or pallescent or glaucescent, pendulous, very long, elongato ramose, costato-angular, closely fibrillose, fibrils divaricate, here and there papilloso-scabrous. Apothecia albid or albido glaucescent, rather small, 2 to 3 mm. broad, margin ciliate, with slender fibrils.

Hab. on trees. *Gunn, Hooker, Lawrence,* Hook. Fl Tasm.; *Stuart,* Hmpe; St. Mary's Pass.

4. NEUROPOGON. Nees. and Flot.

Thallus erect, surface unequal, ramose, terete, with solid axis of horny texture, or hollow. Apothecia nigricant or occasionally pallid, terminal or sub-terminal.

1. *N. melaxanthus*, Ach., pallescent or flavescent or orange, often spotted or ringed with black at the base and elsewhere, especially at the apices, dichotomously ramose, apical ramules attenuate, scrobiculoso rugose or somewhat smooth, rarely papillato scabrous. Apothecia black or pallescent, large, 4 to 12 mm. broad, margin nude.

Hab. on rocks, Arthur Lakes, *Gunn*, Springs on Mount Wellington, *Hooker*, *Mossman*, Hook. Fl. Tasm.; Summit of Mount Wellington, (and *Brown*, Cr.; *Bastow*.)

5. EVERNEA. Ach. Nyl.

Thallus flacid, erect, or ascending, or prostrate, or pendulous, applanate or subterete, laciniose or much branched, destitute of rhizinæ, internally stuppeous. Apothecia lateral, lecanorine. Spores small, ellipsoid, colourless, simple.

1. *E. furfuracea* (?), Mann., cinerascent, dichotomously multi laciniate, upper surface isidioso furfuraceous or fibrillose, under surface canaliculate, black or cæsio nigricant. Apothecia sub-marginal, badio rufous, receptacle smooth.

Hab. on trees. Cheshunt, *Archer*, Hook. Fl. Tasm., where it is marked doubtful, as above, and a note is added that there was only one specimen, and that an aged and unsatisfactory one. It is not improbable that it was *Parmelia physodes*.

6. *Ramalina*, Ach. Fr.

Thallus whitish or pale, compressed, somewhat shining, rigescent, erect or prostrate, laciniate, alike on both sides. Apothecia scattered or marginal, concolorous. Spores colourless, oblong, 1 septate.

1 *R. calicaris*, Hffm., pale glaucous grey, or albido flavescent, rigescent, erect, dichotomously branched, laciniæ linear, compressed, elongated, attenuate at the apices, longitudinally lacunoso canaliculate, cortical layer filamentose. Medulla K —. Apothecia almost terminal, with deflexed and elongated extremities of the lacinæ, like a spur, behind them. Receptacle rugose beneath. Spores straight.

Hab. on trees. S. Esk (Launceston), *Gunn*, Hook. Fl. Tasm.

2. *R. fraxinea*, L., pale yellowish or glaucescent, pendulous, straggling, subrigescent, laciniæ compressed more or less broadly, applanato dilated, lacunose, longitudinally rugose or nervose, elongated and attenuate at the apices, cortical layer filamentose. Med. K —. Apothecia large, marginal, and superficial, brownish yellow or glaucescent, receptacle rugose or plicato rugose. Spores curved.

Hab. on trees. *Stuart*, Hmpe.

3. *R. Eckloni*, Spreng., *var.* 1, *membranacea*, Laur., pallido glaucous or pallid, membranaceous, compressed, laciniate, laciniæ attenuato linear, glabrous, striated, apices acuminate, inciso divided. Apothecia small, marginal or scattered, pallido carneous. Spores ovate or arcuate, 1 septate, ·012 × ·005 mm.

Hab. on trees. St. George's Bay, *Simson*.

Var. 2, *ovalis*, Tayl. = R. *ovalis*, Tayl., straw coloured or pallid, membranaceous, glabrous, minutely lacunose, obovate, simple, or sometimes broadly lobato divided. Apothecia small, scattered all over the upper surface.

Hab. on trees. *Gunn*, Hook. Fl. Tasm.

4. *R. brevis*, Wilson, *var. brevissima*, Wilson, glaucous or pallid, very short (3 to 10 mm. long), broadly applanate, more or less divided at the circumference. Apothecia large, scattered, elevated, disk concave, carneous, or albid, margin often inflexed. Spores oblong, slightly curved or reniform, 1 septate, ·08 to ·09 × ·004 mm.

Hab. on small branches of trees and bushes. Ulverstone; Antill Ponds, *Weymouth*.

5. *R. fastigiata*, Pers., pallid straw coloured, small, densely cæspitose, laciniæ sub-compressed, dilated and inflated upwards, smooth, lacunoso impressed, and nervoso rugose. Apothecia terminal, peltate, sessile, sub-fastigate, on very short divergent extremities of the laciniæ, receptacle plicato rugose. Spores ellipsoideo oblong, straight or curved, 1 septate, ·012 to ·017 × ·006 to ·007 mm.

Hab. on trees. Hook. L. J. Bot.

6. *R. geniculata*, Tayl. = *R. inflata*, Bab. = *R. pusilla*, Le Prev., pallid or straw coloured, cæspitose, sub-fastigiate, ramose, sub-terete or sub-compressed, smooth or obsoletely sub-nervose, often perforated with minute round holes, internally fistulose, branches attenuate. Apothecia pallido testaceous or glauco albid, terminal or sub-terminal, receptacle smooth or rugulose, sessile on a turgid branch or appendiculate. Spores oblong or fusiformi oblong, straight or obsoletely curved, ·009 to ·015 × ·004 to ·007 mm.

Hab. on living and decaying twigs and branches of trees and bushes, Macquarie Plains, *Oldfield*, Cheshunt, *Archer*, Recherche Bay, Lake St. Clair, and St. Patrick's River, *Gunn*, Hook. Fl. Tasm.; Krplh.; Hobart, Brown's River, Launceston; and B. v. M. Vic. Nat., 1887, and *Weymouth*.

SERIES IV. PHYLLODEI.

Thallus foliaceous, depressed, lobate, or variously laciniate or stellate, very rarely cæspitoso intricate; medulla stuppeous. Apothecia peltiform, or lecanorine, or lecideine, or gyrose.

GENUS I. NEPHROMA, Ach. p. parte.

Thallus with cortical layer continued on under surface, and there without nerves; colour above ochroleucous or pallescent, underneath paler or whitish or nigricant. Gonidial stratum containing true gonidia. Apothecia rufous or fuscescent.

1. *N. australe*, Rich., albido pallescent or stramineo pallescent, passim pallidi rufescent, 3 to 4 inches broad, smooth, lobato laciniate, margin sinuate, underneath whitish or whitish-straw colour, glabrous, smooth. Apothecia rufo-fuscescent or fuscous, rotundate or somewhat broader, 4 mm. broad. Spores fuscescent, fusiformi, oblong, ·015 to ·021 × ·006 to ·008 mm.

Hab. Cheshunt, *Archer*, Mount Wellington, *Hooker*, Hook. Fl. Tasm. Probably these specimens belong to the following species.

2. *N. antarcticum*, Jacquin, stramineous or glaucescenti stramineous, large or smaller, lobato laciniate, margin undulate or crenate, above lacunoso or foveolato impressed, underneath bullate, smooth, albid. Apothecia rufo-fuscous or rufous, reniform, broad, back of thalline receptacle rugose. Spores fuscous, oblong, ·02 to ·024 × ·006 to ·008 mm.

Hab. on bark of trees, Mount Wellington; Circular Head, *Weymouth*. Distinguished as a species by the upper surface foveolato impressed, and the lower bullate and whitish.

2. NEPHROMIUM, Nyl.

Like the preceding, but more fragile; colour lurid, glaucescent or fuscescent or rarely pallid. Gonimic stratum of granula gonima generally moniliformi concatenated.

1. *N. lævigatum*, Ach. *var. papyraceum*, Hffm., lurido fuscescent or glaucescent, thin, not large, orbicular, rotundato lobate, margin sinuato crenate, opaque, scarcely shining, beneath pale, glabrous and slightly rugulose. Apothecia fusco-rufous, margin of receptacle crenulato unequal, back of receptacle minutely depresso granulate. Spores fuscescent, fusiformi, oblong, 3 septate.

Hab. on branches of trees. St. Mary's Pass.

2. *N. cellulosum*, Ach., livido castaneous or castaneo fuscescent, diam. 4 inches, reticulato foveolate or lacunose lobate, below white or whitish pallescent, bullato unequal, glabrous. Apothecia rufous, to more than ½ inch broad, receptacular margin scarcely exceeding disk, and entire. Spores fuscescent, 3 septate, ·016 to ·019 × ·006 to ·007 mm.

Hab. on trees, Johnny's Creek, *Oldfield*, Cheshunt, *Archer*, Mount Wellington, Hook. Fl. Tasm.; Nyl.; Mount Wellington, and *Weymouth*.

3. Peltigera, Ach.

Thallus membranaceous, lobate, fragile, cortical layer not continuous on the under surface, and there generally nerved and rhizinose. Apothecia marginal on upper surface of thallus. Spores 8, colourless or slightly fuscescent, fusiform, 3 to 5 to 7 septate. Stratum gonidiale of granula gonima.

1. *P. canina*, L., cinerascent or cinereopallescent, opaque, more or less longitudinally lacunoso impressed, adpresso tomentellose, rotundato lobate, under surface longitudinally adpresso albo tomentose, with prominent pale anastomosing villoso tomentose nerves extending to the very margin, and clothed with tufts of pale rhizinæ. Apothecia fuscous or fusco rufous, adnate, margin nearly entire, back of receptacle uniformly tomentose, almost sub-furfuraceous. Spores 3 to 5 septate, ·066 to ·07 × ·0045 mm.

Hab. on mossy earth. *Stuart*, Hmpe.

Var. membranacea, Ach., thallus thinner, more glabrous.

Hab. Mount Wellington, *Brown*, Cr.

2. *P. spuria*, Ach. = *P. canina*, *var. pusilla*, Fr. of Hooker, cinereo virescent, small, digitato lobate, lobes ascending, smooth, glabrous in lower part, adpresso tomentellose upwards towards the apothecia, under surface whitish, with thick coarse spongioso tomentose nerves, and interstitial longitudinal whitish lacunæ. Apothecia fuscous or rufo fuscous, roundish, margin irregularly crenulate or denticulate, back of receptacle densely irregularly spongioso tomentose. Spores aciculari fusiform, 3 to 7 septate, ·056 to ·075 × ·0035 to ·0045 mm.

Hab. on earth. Southport, *Stuart*, Hook. Fl. Tasm.; Nyl.

3. *P. polydactyla*, Hffm., glauco pallescent or pallido fuscescent, digitato lobate, lobes ascending, glabrous and shining, smooth or obsoletely impressed, underneath with thick coarse spongioso tomentose fusco nigricant anastomosing more or less flattened nerves, and interstitial whitish lacunæ. Apothecia fuscous or fusco rufescent, longitudinal revolute margin irregularly crenulate, back of receptacle sub-verrucoso tomentose. Spores attenuato fusiform, 3 to 7 septate.

Hab. on mossy earth. *Archer*, *Laurence*, *Stuart*, *Hooker*, Hook. Fl. Tasm.; Ulverstone, St. Mary's Pass, Mount Wellington (and *Weymouth)*; and Launceston, and Crag Creek, and New Town Falls, *Bastow*.

4. *P. horizontalis*, L., pale or pallido fuscescent or glauco pallescent, rotundato lobate, glabrous, smooth or slightly impressed, shining, margin sinuato crenate and slightly undulate, underneath with pale brown and fuscous black coarse flattened anastomosing or confluent nerves, and interstitial white lacunæ. Apothecia fuscous or fuscous black, rotundate or elliptical, plane, horizontal, margin irregularly crenulate,

often inflexed, back of receptacle verrucoso tomentose. Spores 6 to 8, colourless or pale fuscescent, fusiform, 3 septate, ·03 to ·042 × ·006 to ·007 mm.

Hab. on mossy rocks and trees, Cheshunt, *Archer*; Hook. Fl. Tasm.

4. Heterodea, Nyl.

Thallus laciniate, sub-corneous and fragile when dry, the under surface tomentose, with cyphelloid spaces. Apothecia marginal, biatorine. Spores 8, simple, ellipsoid.

6. *H. Müelleri*, Hmpe. (Nyl.) = *Sticta Müelleri*, Hmp. = *S. cetrarioides*, Bab. = *Platysma Müelleri*, Nyl., flavido glaucescent, passim rufo-fuscescent, vivid green when fresh and moist, orbicular, 2 inches wide, smooth, sublacunose, rigescent, lineari laciniate, laciniæ sinuato multifid, the margin curved downwards, the apices broader, crenato incised, subascending, underneath fuscous, sub-spongiose, with black marginal fibrils, and here and there cyphelloid whitish bare spaces. Apothecia carneo rufous, sub-pruinose, strictly marginal, 2 to 2½ inches wide, biatorine or cephaloid. Spores simple, fusiformi ellipsoid, ·009 to ·01 × ·0025 to ·003 mm.

Hab. on earth, Hook. Fl. Tasm.; Hmpe.; Nyl. The upper surface of the thallus, which when fresh and moist looks like a hepatica lying loose on the earth, shrinks when dry, so that the whole plant curls up, showing only the fuscous tomentose under surface, and bears some resemblance to dried sheep dung.

5. Stictina, Nyl.

Thallus membranaceo lobate or lobato laciniate, the under surface rhizinose, and with cyphellæ, either true and urceolate or pseudo and pulverulent. Apothecia lecanorine. Spores fusiform, 1 to 3 rarely pluri-septate. Gonidial stratum of dark blue granula gonima.

A. Pseudo cyphellæ yellow.

1. *S. crocata*, L., lurido fuscescent, shining, broadly rotundato lobate, crenate, reticulato lacunose, reticulations and margins usually bearing citrine soredia, under-surface fusco nigricant, tomentose. Apothecia scattered, blackish; margins crenate, at length excluded. Spores 6 to 8, fuscescent, oblongo fusiform, 1 septate, ·02 to ·032 × ·009 to ·01 mm.

Hab. on earth, rocks, and trees. *Brown*, Cr.; Hook. L. J. Bot.; everywhere, *all collectors*, Hook. Fl. Tasm.; *Stuart*, Hmpe.; Krplh.; Mount Wellington, etc.; and *Bastow*, *Weymouth*.

2. *S. carpoloma*, Del., glaucescenti pallescent or flavido cinereo pallid, 3 to 5 inches wide, somewhat rigid, almost

shining, wholly lineari laciniate, laciniæ lineari lobate, lobes short, retuse at margin, upper surface scrobiculato unequal, underneath somewhat bullato unequal, pallid, or fuscescent; tomentum thin or evanescent, pseudo-cyphellæ small, citrine. Apothecia black, marginal, 1½ to 2 mm. broad, thalline margin smooth. Spores fuscous, fusiformi oblong, bilocular, ·023 to ·027 × ·009 to ·01 mm.

Hab. on trees. *Brown*, Cr.; Nyl.; Mount Wellington.

3. *S. gilva*, Thunb., dirty lurido pallescent, or lurido fuscescent, paler at circumference, 3 to 5 inches broad, rigescent, somewhat shining, laciniato lobate, laciniæ briefly lobate, often almost imbricate, above scrobiculato unequal, within medullary stratum white, underneath nigricant or dark fuscous, margin pallescent, tomentum moderate. Apothecia fuscous or black, opaque, 2 to 3 mm. wide, thalline receptacle rugoso scabrous, pallid, margin crenate, concolorous or pale brick-red. Spores as in *S. crocata*.

Hab. on stones and trees, Nyl; Launceston.

4. *S. granulata*, Bab., sordidly cinereo pallid or cinereo fuscescent, especially at circumference, dilated, rigid, thicker than *S. carpoloma*, nearly opaque, laciniato lobate or deeply laciniate, laciniæ crenate or lobato crenate, scrobiculate or scrobiculato unequal, margin and sometimes rugæ granuloso albido serediate, underneath pallid, tomentum moderate, pseudo cyphellæ white or yellow, often large. Apothecia not seen.

Hab. on trees. Cheshunt, *Archer*, fertile, *Hooker* and *Gunn*, barren, Hook. Fl. Tasm.; Nyl.

B. Pseudo cyphellæ white.

5. *S. cinamomea*, Rich.=*S. fragillima*, Bab., glauco pallid or pale yellow, passim rufescenti fuscescent, thinly membranaceous, rigescent, fragile, smooth, or here and there obsoletely scrobiculato unequal, lineari laciniate, laciniæ pinnatifid, margin here and there minutely laciniato dissect, apex dichotomous, underneath fuscoochraceous or ochraceo pallid, especially towards margin, tomentum rhizinose, short, deficient at margin. Laciniæ underneath costate or sub-costate in the middle and especially towards centre of plant, above canaliculato impressed. Apothecia fuscous or rufescent, 1½ to 3 mm. broad, scattered or sub-marginal, thalline margin irregularly denticulato lacerate or sub-crenulate, and at length nearly evanescent. Spores fuscescent or fuscous, oblongo fusiform, 1 to 3 septate, ·024 to ·03 × ·009 to ·011 mm.

Hab. on rocks, earth, logs, and trees in shady places, Nyl.; Mount Wellington, Mount Arthur, St. Mary's Pass; Tasman Peninsula and Mount Bischoff, *Weymouth*, and Mount

Wellington, and Knocklofty, and Maria Island, and Circular Head, *Bastow*; B. v. M. Vic. Nat., Oct., 1887.

C. Cyphellæ urceolate or thelotremoid.

6. *S. fuliginosa*, Dicks., cervine or cinereo fuscescent, 2 to 4 inches broad, rigescent, either somewhat smooth or unequal, or here and there scrobiculato rugose, rather shining or nearly opaque, monophyllous, variously lobed, lobes rotundate, above frequently sprinkled with fuscous or nigricant coralloid isidia, underneath pallid, tomentum moderate, cyphellæ white or pale. Apothecia fusco rufescent, 1 mm. broad, scattered, often albido piloso ciliate at margin. Spores colourless, fusiform, 1 to 3 septate, ·027 to ·04 × ·007 to ·008 mm.

Hab. on trees and mossy rocks. Cheshunt, *Archer*, Hook. Fl. Tasm.

7. *S. sylvatica*, Huds., cervine or cinereo fuscescent, 4 to 6 inches or more, rather rigescent, nearly shining or sub-opaque, lightly scrobiculato unequal, laciniato lobate, lobes variously divided, divisions obtuse at apex, upper surface here and there lightly furfuraceous, beneath tomentose, fuscous or fuscescent, generally near margin pallescent. Apothecia as in *S. fuliginosa*, but rather larger and margin nude.

Hab. on mossy rocks and trunks of trees, *Stuart*, Hmpe.

8. *S. limbata*, Sm., glauco lurid or pale cervino fuscescent, 2 to 4 inches, scarcely rigescent, smooth or very lightly scrobiculate, unequal, scarcely shining, monophyllous, variously lobate, lobes rotundate, margin usually covered with cinerous or sordid bluish grey soredia, often with round patches of the same on the upper surface of the thallus chiefly towards the margin, underneath pallid, tomentum moderate or evanescent, cyphellæ white or whitish, moderate. Apothecia not seen.

Hab on trunks of trees and mossy rocks, Mount Wellington; Tasman Peninsula, *Bastow*. The last three species are similar and may be easily confounded.

9. *S. quercizans*, Ach., lurid, cervino pallescent or cervino fuscescent, 4 to 10 inches, thinly membranaceous, scarcely rigescent or shining, smooth, laciniato lobate, lobes variously crenato divided, margin chiefly granulato isidiose and then somewhat reflexed, undulate, underneath tomentose, fuscescent, but at margin pallid or ochraceo pallid, cyphellæ urceolate. Apothecia generally sub-marginal, fusco rufescent, 2 to 3 mm. broad, thalline margin thin, nude. Spores colourless, fusiform, 3 septate, ·03 to ·032 × ·008 to ·009 mm.

Hab. on trees and mossy rocks. Nyl.

10. *S. filicina*, Ach., pallido flavescent, or pallido cinereo flavicant, small or moderate, rigescent, or thinly membranaceous and scarcely rigescent, somewhat shining or sub-opaque, smooth, stipitate, or sub-stipitate, lobato incised, lobes beneath at least towards the base costate, margin variously sinuate, underneath ochraceo pallid, tomentum thin, or sometimes none. Apothecia rufous or badio rufous, scattered, 2 to 3 mm. broad, thalline margin pallido testaceous, entire, or sometimes very slightly crenulate. Spores colourless, fusiform, 1 to 3 septate, ·03 to ·04 × ·008 to ·009 mm.

Hab. Johnny's Creek, and Back River Gully, *Oldfield*, Cheshunt, *Archer*, Hook. Fl. Tasm.; Krplh.

Var. latifrous, Rich., larger and broader, 4 to 7 inches or more.

Hab. on trunks of trees, *Hooker*, near caves Back River, *Oldfield*, Hook. Fl. Tasm.; Krplh.

6. STICTA, Ach. pro parte.

Thallus variously lobed, or laciniato lobate. Rhizinæ simple. Gonidial stratum of yellowish green gonidia.

A. Pseudo cyphellæ yellow.

1. *S. aurata*, Ach., glaucous or testaceo rubricose, or rosy rubricose, widely expanded (to one foot), somewhat firm, opaque or scarcely shining, lobato divided, lobes sinuato incised, margins crenato undulate, generally citrino pulverulent, medullary stratum citrine, underneath fusco nigricant or fuscescent, margin beneath pale, briefly tomentose. Apothecia spadiceous black or black, largish or large, 5 to 8 mm., receptacle sub-podicellate in young apothecia, thalline margin thin, often inflexed, marginal or sub-marginal. Spores fuscescent, 3 septate, ·024 to ·028 × ·007 to ·008 mm.

Hab. on trunks of trees and mossy rocks. Cheshunt, *Archer*, St. Patrick's River, *Gunn*, Mount Wellington, *Hooker*, Hook. Fl. Tasm.; Krplh.; Wilson.

Var. rubella, Tayl. = *S. rubella* of Hooker, dull, lurid or pallido rubricose, widely lobate, 3 to 6 inches, firm, opaque, covered with thin white down, somewhat smooth, or obsoletely foveolato scrobiculoso unequal, here and there with punctiform citrine soredia.

Hab. Hook. L. J., Bot.; Mount Wellington, St. Mary's Pass.

2. *S. orygmæa*, Ach., flavido pallescent, or livido glauco pallescent, broadly lobate, 3 inches or more, thinly membranaceous but rigescent, slightly shining, closely scrobiculato unequal, or sometimes reticulato costate, lobes rotundate, margin broadly and unequally crenate, yellow within, underneath ochraceo pallescent, very thinly tomentose, here and

there often nearly nude. Apothecia fuscous black or black, $1\frac{1}{8}$ to 2 mm. broad, thalline receptacle smooth, margin crenulate at length almost obliterated. Spores fusiform, ·022 to ·036 × ·008 to ·01 mm.

Hab. on trees. Southport, *Stuart*, Hook. Fl. Tasm.; Hook. L. J. Bot.; Nyl.; Mount Arthur; Blue Tier, *Simson*, Tasman Peninsula, *Weymouth*.

3. *S. Urvillei*, Del., coriaceo flavescent or ochraceo pallid, widely expanded, 4 inches or more, soft, opaque, or here and there somewhat shining, smooth or passim lightly scrobiculato unequal, laciniato divided, laciniæ lobate, crenate, or variously divided, citrine within, underneath thinly tomentose, pallid, or in the centre fuscescent. Apothecia fuscous black or black, scattered, at length 3 to 5 mm. broad, thalline margin rugose. Spores fusiform, 3 to 5 septate, ·038 to ·048 × ·006 to ·007 mm.

Hab. on bushes and among mosses. B. v. M. Vic. Nat., 1887, Oct.

Var. Colensoi, Bab., firmer and scrobiculate, margins with granulose or lobulose isidia. Apothecia sometimes 7 mm. broad. Spores 1 to 3 septate, ·034 to ·04 × ·008 to ·011 mm.

Hab. in forests on bark of fagus, very abundant, *Gunn*, *Hooker*, Hook. Fl. Tasm.; Nyl.; Krplh.

B. Pseudo cyphellæ white.

4. *S. dissimulata*, Nyl., *var. multifida*, Laur., lurido glaucescent or pallido cervine or pallido lurid, of moderate size, somewhat flaccid, thin, rather shining, scrobiculato unequal, lineari laciniate, laciniæ narrow, sinuato multifid, margin often fringed with minute lobules or lacinioles, apical lobes linear, obtuse or retuse, underneath pallid or at the centre fusco pallescent, tomentum rhizinose, fuscescent or pale whitish, of moderate length, towards the margin evanescent. Apothecia fuscous, receptacle granulato rugulose, margin scarcely prominent, at length nearly excluded. Spores fuscous, oblongo fusiform, 1 or 3 septate, ·023 to ·032 × ·006 to ·008 mm.

Hab. on trunks of trees, Anna Maria River, *Brown*, Cr.

5. *S. Freycinetii*, Del., = S. *glabra*, Tayl., ochroleucous or pallid, rarely pallido rufescent, 5 to 10 inches, scarcely rigescent, slightly shining, smooth or obsoletely unequal, laciniato lobate, lobes sinuato divided, crenate, margins often partly albo sorediate, underneath slightly tomentose, fuscous or fusco cinereous, at margin pallescent or pallid. Apothecia rufous or rufo fuscescent, 2 to 4 mm. broad, receptacular margin in young state inflexed, then as if thinly lacero fimbriate or sub-crenulate, marginal or scattered. Spores colourless, oblong or oblongo fusiform, 3 septate, ·022 to ·03 × ·007 to ·009 mm.

Hab. on trees, common, Mount Wellington (and *Brown*, Cr.); everywhere, by all collectors, Hook. Fl. Tasm.; Nyl.; Krplh.; *Simson*, *Bastow*, *Weymouth*.

F. 1. ***rugosa***, Nyl., thallus rugose, Nyl. Syn. Meth.

F. 2. ***angusta***, Wilson, small, narrow, linear.

Hab. Mount Wellington, Blue Tier, *Simson*.

Var. 1, *fulvo cinerea*, Mont., more widely lobate, margin crenate or crenato incised, underneath ochraceo fuscescent, margin lighter, or all ochraceo pallid. Apothecia dark rufous, often larger, 3 to 5 mm. broad.

Hab. Mount Wellington.

Var. 2. *prolifera*, Mull., Arg. = *S. glabra*, Tayl., Hook. L. J. Bot.

6. *S. fossulata*, Duf. = *S. linearis*, Tayl. = *S foveolata* of Babington = *S. Billardierii*, Del. of Mull., Arg., pallid or pale lurido glaucescent or glaucescenti pallid, small or moderate or large to a foot or more, scrobiculato foveolate, and transversely costate between the pits, lineari laciniate, laciniæ subpinnatifid, intricate, apices retuse, underneath pallid or fuscescent, rhizinose tomentum moderate or scanty, or obsolete, pseudocyphellæ white or occasionally whitish-yellow, sometimes rather rare. Apothecia rufous or fusco rufous or nigricant, 2 to 3 mm. broad, marginal, plane, thalline margin at length excluded. Spores fuscous or fuscescent, oblongo fusiform, 1 to 3 septate, ·02 to ·032 × ·008 to ·011 mm.

Hab. on trees, common, Derwent River, *Brown*, Cr.; Springs on Mount Wellington, *Oldfield*, *Hooker*, Hook. Fl. Tasm.; Hook. L.J. Bot.; Nyl.; Krplh.; Mount Wellington; and Mount Dromedary, etc, *Bastow*; Blue Tier, *Simson*; Tasman Peninsula, *Weymouth*; Mount Wellington and elsewhere.

Var. 1. *cellulifera*, Tayl., thallus thick, rigid, more broadly laciniato divided and scarcely to the centre, lobes sub-palmate, profoundly reticulato scrobiculate, underneath pallid, or towards the centre dark and more reticulato rugose and thinly rhizineo tomentose.

Hab. Mount Wellington.

Var. 2. *Richardi*, Bab., glaucescent, a foot wide.

Hab *Gunn*, Hook. Fl. Tasm.

C. cyphellæ thelotremoid.

7. *S. stipitata*, C. Kn., glauco pallid, when moist a bright green, here and there rufescent, sub-erect, 2 to 3 inches high and sometimes 4 inches broad, thin, somewhat rigid, scarcely shining, obsoletely scrobiculate, laciniato lobate, laciniæ subpinnatifid, margins sinuate and undulate, sinuses round and somewhat large, apices often broadly dilated and crenate,

sometimes deeply divided or even laciniatule, underneath pale fulvous, tomentose, tomentum short, sordid, denser towards the base, which often ends in a stout woody tomentose stipe. Apothecia fusco rufous, 1 to 3½ mm. broad, scattered, thalline margin entire, often at length obliterated. Spores colourless, fusiform, 5 septate, ·035 × ·007 mm.

Hab. on trunks of trees and fern trees and logs. Mount Wellington; Gordon River, *Allport*. The plants generally grow closely crowded together and imbricated, often covering many feet of tree or log with sub-ascending fronds. The juvenile state of this lichen is very remarkable, and, so far as I am aware, it is unique among lichens. It is about 1 inch high, fruticulose, ramose, the branches spreading out in one plane secundo incurved, the stem and lower side of the branches terete, fulvous, tomentose, the upper side plane, smooth, plumbeous, the higher branches slightly dilated, the last divisions extremely minute. The diameter of the stem is about 1 mm. The plumbeous colour is owing to the presence of numerous blue-green granula gonima disposed in a moniliform manner immediately under the upper cortex. It is notable that in the juvenile state the gonimic stratum is composed of granula gonima, while that of the adult plant is of gonidia. The adult form of the plant is developed from the apex in the shape of a minute, broad, green frond, containing true gonidia. The stem then grows thicker and more tomentose, and at length loses the plumbeous branches. Many plants wither away without developing the frond.

4. *S. damæcornis*, Ach., *var. macrophylla*, Del. = *S. macrophylla* of Hampe, pale rufescent or hepatico fuscescent, usually widely expanded, 4 to 6 inches or even a foot or more, rather rigescent and shining, smooth laciniato, lobate, laciniæ pinnatifid, apices dichotomous obtuse, underneath fusco nigricant, margin pallescent or cinereo fuscescent or ochraceo pallescent, tomentum moderate, thin, or none. Apothecia fusco rufous or fusco nigricant, 1½ to 3 mm. broad, marginal or scattered, thalline margin obsoletely crenulate or nearly entire. Spores colourless, or lightly fuscescent fusiform, 1 to 3 septate, ·026 to ·036 × ·008 to ·011 mm.

Hab. Hook. L. J. Bot.; *Stuart*, Hmpe.

Var. sub-caperata, Nyl.=*Sticta sub-caperata*, Nyl. of Cr., pale lurid, size moderate, thinner than *macrophglla* and more imbricato lobate. Spores ·026 to ·046 × ·009 to ·011 mm.

Hab. Mount Wellington, *Brown*, Cr,

5. *S. sub-variabilis*, Nyl., sub-stipitate, glaucous grey, smooth, shining, laciniato lobate, often dichotomous, terminal laciniæ linear, narrow, furcate, with rounded apices, lateral laciniæ smaller, crowded, sub-erect, beneath pale flesh pink,

tomentum short, snuff brown, margin nude. Apothecia not seen.

Hab. Mount Wellington, Mount Arthur; Gordon River, *Allport*.

6. *S. cinereoglauca*, Tayl., glaucescent or cinerascent, usually cervine at circumference, about 3 inches broad, rigescent, scarcely shining, lobate, lobes crowded, sinuate, somewhat crenate or spreading at the margin, smooth or obsoletely unequal, beneath pallid or slightly ochraceo pallid, tomentum short, concolourous, or whitish. Apothecia badio rufous, 1 to 1½ mm. broad, thalline margin slightly cremulate. Spores colourless, fusiform, 1 septate, ·036 to ·05 × ·007 mm.; attentuate at each end.

Hab. Hook. L.J. Bot.; Hmpe.; Rev. Mr. Babington compares it with *Stictina limbata*.

7. *S. prolificans*, Nyl., B. v. M. Vic. Nat., 1887, Oct.

7. LOBARIA, Hffm. pro. p.

Thallus variously lobed or laciniato lobate. Rhizinæ simple. Ecyphellate, underneath bullate, reticulate tomentose. Gonidial stratum in some species formed of green gonidia, in others of dark blue granula gonima.

1. *L. scrobiculata*, Scop., glauco flavescent, reticulato scrobulate, sorediate, underneath albido bullate, tomentum fuscescent. Apothecia scattered, margin thick, entire, inflexed. Spores colourless, fusiform, 3 to 7 septate, ·05 to ·08 × ·006 to ·007 mm.

Hab. Risdon Cove, *Brown*, Cr.; Hmpe.; Hook. L.J. Bot.; *Miss Lilley*.

8. RICASOLIA, D. N.

Thallus lobate or laciniate, affixed by fasciculate rhizinæ. Cyphellæ, none usually. Gonidial stratum of small green gonidia. Spermagones in mastoid prominences. Spores fusiform and septate.

1. *R. herbacea* (?), Huds., pallid or pale lurid, or here and there glauco pallescent, widely expanded, 6 inches to a foot and more, thinly membranaceous, scarcely rigescent, somewhat shining, here smooth and there rugulose, lobate, lobes crowded, rotundato crenate and undulate at margin, underneath pallid, rhizinæ concolorous or whitish. Apothecia rufous, 4 to 8 mm. broad, thalline margin entire or obsoletely and thinly crenulate, opaque, obsoletely granulato rugulose. Spores colourless, and at length often fuscescent, fusiform, often broadly fusiform, 1 septate, ·026 to ·046 × ·009 to ·012 mm.

Hab. on rocks and trunks of trees, *Gunn*, Hook. Fl. Tasm., where is is marked doubtful as above, and a note is added that there was but a single specimen, and that in bad condition.

9. Parmelia, Ach. Nyl.

Thallus lobate or laciniate, expanded, sometimes shining, medulla stuppeous. Apothecia scattered. Spores 8, ellipsoid, simple, small. Spermatia acicular, fusiformi incrassulate at the acute apices.

1. *P. perlata*, L., albo glaucescent or whitish, dilated, lobed, lobes rotundate, sub-imbricate, often albo sorediate on the margins, under surface fuscous black or black, and pale towards margin. Medulla K yellow C —. Apothecia badio rufous, margin entire. Spores ·011 to ·017 × ·007 to ·01 mm.

Hab. (various collectors) Hook. Fl. Tasm.; Hook. L. J. Bot.; Hmpe.; Krplh.; Tasman Peninsula, *Weymouth*. Often confounded with the following species, which is much more common, and is readily distinguishable by the rimulose upper surface. seen with a lens, and by the perforated apothecia, and especially by the chemical reaction.

2. *P. perforata*, Wulf., whitish or glaucous white, lobate or lobato sinuate or sinuato divided, smooth, minutely reticulato rimulose, margin often albo sorediate, under surface fuscous black or black. Medulla K yellow, then red. Apothecia badio rufescent, or fusco rufous, often medio perforate, margin entire.

Hab. Brown's River, St. Mary's Pass, Launceston, Mount Arthur; Knocklofty, *Bastow*; Circular Head, *Weymouth*.

3. *P. tenuirima*, Tayl., = *P. sulcata* of Taylor = *P. saxatilis* of Babington and Hampe, glauco cinereous or glauco pallescent or whitish, usually glaucous or virescent in growth; rigescent, somewhat shining, laciniate, laciniæ sub-pinnatifid, sinuate, concave, apices crenate and crenato divided, upper surface here and there scrobiculato impressed, and—especially towards the apices—marked with white, small rugulosities, underneath black, fibrillose. Medulla K yellow, then red. Apothecia elevated, at length appressed, incurved, rufo castaneous, or rufescent, or fusco rufous, sometimes 1 inch broad, at length splitting into lobes. Receptacle reticulato scrobiculate.

Hab. on trees and rocks, Derwent River, *Brown*, Cr.; Launceston, *Gunn*, *Hooker*, Hook. Fl. Tasm.; Hook. L. J. Bot.; Hmpe.; Nyl.; Brown's River, Mount Wellington, St. Mary's Pass, Launceston, Mount Arthur; Tasman Peninsula, *Weymouth*; Knocklofty, *Bastow*.

Var. 1, *corallina*, Mull. Arg., the white markings on the upper surface more numerous and reticulate, centre crowded with bulbous isidia.

Hab. on rocks, Launceston.

Var. 2, *multifida*, Wilson, pallid or glaucescenti pallid, laciniate, laciniæ narrow, sinuate, multifid, very laxly affixed, under surface densely hirsute. Apothecia large, over an inch wide, lacerato lobate, surface undulate, receptacle corrugate with elevated reticulations.

Hab. on Mount Arthur.

4. *P. saxatilis*, L., *var. omphalodes*, L., = *P. tenuissima*, Hmpe., fuscous or nigricant, shining, somewhat smooth, reticulato rugulose, laciniose, laciniæ sinuato multifid or sinuato incised or lobate, apices retuse, black and fibrillose beneath. Medulla K yellow, then red. Apothecia spadiceo badious or fuscous, margin entire or crenulate.

Hab. on alpine rocks, Hmpe. Query, *P. tenuirima ?*

5. *P. conspersa*, Ehrh., pale ochroleucous, orbicular, laciniato divided, laciniæ appressed, contiguous or imbricate, margins sinuato incised or crenate, undulate, under surface fuscous black or fuscescent, nigro fibrillose. Medulla K yellow, then red. Apothecia spadiceous or fuscous, margin thin, inflexed. Spores ·008 to ·012 × ·005 to ·008 mm.

Hab. *Gunn*, *Hooker*, *Archer*, *Oldfield*, Hook. Fl. Tasm.; Hook. L. J. Bot.; Hmpe.; Nyl.; Krplh; Hobart, Mount Wellington, St. Mary's Pass, Launceston; and Bellerive, and Knocklofty, *Bastow*.

Var. 1, *laxa*, Mull. Arg., = *P. tasmanica*, Tayl., = *P. incisa*, Tayl., fide Mull. Arg., not appressed, imbricate, laciniæ narrow, multifid, underneath fuscous, or fuscescent, or pale, nude.

Hab. Hook. L. J. Bot.

Var. 2, *isidiata*, Anzi., centre of thallus densely isidiose.

Hab. Mount Wellington.

Var. 3, *stenophylla*, Ach., laciniæ of thallus narrower, much more divided, and imbricate.

Hab. Launceston, *Miss Lilley*.

6. *P. australiensis*, Cr., albido flavescent, opaque, beneath nigricant, nude, laciniæ long, convolute. Medulla K—C pale red. Apothecia not seen. Similar in appearance to *P. vagans*, Nyl.

Hab. on rocks, Mount Wellington, *Brown*, Cr.

7. *P. caperata*, L., flavescent or sub-stramineous, dilated, lobato incised, rugose, under surface black, margin paler, nigro

rhizinose. Thal. K f yellow C + Medulla K — C —. Apothecia badio rufescent, margin crenulate, pulverulent. Spores ·017 to ·02 × ·007 to ·01 mm.

Hab., various collectors, Hook. Fl. Tasm.; *Stuart*, Hmpe.; Krplh.; Brown's River, Hu n River, Hobart, St. Mary's Pass, Falmouth, Launceston, Ulverstone; Jordan, and Antill Ponds, and Tasman Peninsula, *Weymouth*.

8. *P. sub-caperatula*, Nyl. in lit., like a smaller *P. caperata*, thallus diminshed, adnate, lobes crenato incised, beneath black even at the extreme margin. Thal. K—C—. Apothecia pallido testaceous or testaceo rufous, 1 to 3 mm. broad, concave with receptacular margin thin, nearly entire or obsoletely crenulate. Spores 014 to ·017 × ·007 to ·008 mm.

Hab. on bark of trees, Derwent River, *Brown*, Cr.

9. *P. rutidota*, Tayl., = *P. ochroleuca*, Mull. Arg., fid. ejus, flavicant, orbicular, 3 to 4 inches wide, closely adhering, smooth, longitudinally plicate, centre minutely corrugate and tawny. Apothecia central, crowded, concave, disk rufescent, margin thin at length crenulate. Much smaller than caperata and lighter in colour.

Hab. Hook. L.J. Bot.

10. *P. tiliacea*, Ach., glaucescent, sub-orbicular, laciniato lobate, laciniæ rotundate, smooth, margin sinuato crenate. Medulla C red. Apothecia badio rufescent, chiefly in the centre of the thallus, receptacle smooth, margin nearly entire.

Hab. Cheshunt, *Archer*, Hook. Fl. Tasm.; Mount Stuart, *Weymouth*; Brown's River, Bellerive, Hobart, St. Mary's, Launceston (and *Bastow*).

Var. 1 *scortea*, Ach., orbicular, sinuato lobate, lobes short, rotund, undulate, margin inciso crenate, centre of thallus isidiiferous and pulverulent; Med. C red.

Hab. on dead wood and trees, Launceston.

Var. 2, *Hookeri*, Tayl., = *sub-lævigata*, Nyl., fide Mull., Arg., pinnatifido divaricate, laciniæ appressed, linear, narrow, distinct, sinuato incised, apices truncato furcate, beneath very atro rhizinose; Med. C red.

Hab. on small branches of trees and bushes, Launceston; Tasman Peninsula, *Weymouth*.

11. *P. ulophylla*, Ach., orbicular, pallido virescent or cinereo virescent or pallid, glabrous, lobato laciniate, laciniæ rarely sub-rugose, apices rotundato lacerato crenate, margins elevated, crisp, and albo pulverulent, beneath sordid white, ruguloso fibrillose; Med. C red. Apothecia scattered, small fuscous, margin thin, at length rugoso crenate or pulverulent.

Hab. Brown's River, Hobart, St. Mary's Pass, Ulverstone, Mount Arthur, Launceston (and *Bastow*).

12. *P. laceratula*, Nyl., = P. *subflava* Tayl., fide Mull. Arg., whitish or albo glaucescent, thinly membranaceous, 1 to 3 inches wide, rugulose or passim smooth, lobato laciniate, margin crenate or crenato incised, or oftener for the most part lacero dissect or nearly isidioso dentate, beneath white, and with concolorous fibrils few and longish. Apothecia badio testaceous or pale badious, 2½.to 3½ mm. broad, receptacle subpodicellate, margin thin, entire, or sub-entire. Spores ·012 to ·013 × ·007 to ·01 mm.

Hab. Hook. L. J. Bot.

13. *P. adpressa*, Krplh.; B. v. M., Vic., Nat., 1887, Oct.

14. *P. albata*, Wilson, white or bluish-white, opaque, with here and there sorediate patches, lobate or laciniato lobate, undulate, lobes rotund, crenato incised, beneath white or whitish, sometimes reddish-white, with scattered longish fibrils, concolorous, or cærulescent, or cæruleo nigricant; Med. K yellow C—. Apothecia not seen.

Hab. on rocks, Launceston.

15. *P. olivacea*, L., olivaceo fuscous, orbicular or sub-orbicular, smooth or minutely corrugated or sometimes varnished, laciniato lobate, lobes appressed, plane crenate, subopaque, under surface concolorous; Med. K—C—. Apothecia badious or badio rufescent, margin entire. Spores ·01 to ·019 × ·007 to ·01 mm.

Hab. on earth, rocks, and stones. Richmond, *Oldfield*, *Hooker*, Hook. Fl. Tasm.; Hobart, Launceston; Knocklofty, *Bastow*.

Var. prolixa, Ach. dark olivaceous, sub-orbicular or effuse, laciniate, laciniæ narrow, variously divided, multifid, plane, crenate, incised, under surface nigricant, fibrillose. Spores ·009 to ·012 × ·005 to ·006 mm.

Hab. Nyl. Probably subprolixa, a variety of *P. imitatrix*, Tayl.

16. *P. lanata*, L., nigricant or fusco nigricant, terete, slender, decumbent, stragglingly ramose, entangled, nearly shining. Apothecia lateral, concolorous, receptacular margin sub-entire or nearly granular, unequal. Spores ·009 to ·012 × ·007 to ·008 mm.

Hab. Mount Wellington, *Brown*, Cr. A filamentous form of *Umblicaria cylindrica*, which is found on the mountain, is very apt to be taken for this species.

17. *P. alpicola*, Th. Fr., nigro olivaceous, crustaceo cartilaginous, orbicular or expanded, sub-opaque, laciniæ convex, rugoso plicate, imbricate and complicate, narrow, toruloso intricate, apices incurved, under surface very black, sparsely fibrillose; Med. K—C—. Apothecia nigricant, concave, margin entire. Spores ·007 to ·012 × ·005 to ·009 mm.

Hab. Mount Wellington.

18. *P. physodes*, L., whitish, sub-stellate, laciniæ multifid, plane, glabrous, smooth imbricate, under surface naked, rugose, fuscous black, apices inflated and badio pallescent, Thal. K yellow, C +, Med. K — C —. Apothecia spadiceous or badio rufescent, margin entire. Spores 006 to ·008 × ·005 to ·006 mm.

Hab. Hook. L. J. Bot.; Hmpe.; Krplh.; Mount Wellington, Mount Arthur; Blue Tier, *Simson*; Tasman Peninsula, *Weymouth*; Knocklofty and Cascades, *Bastow*.

Var. 1. *vittata*, Ach., laciniæ narrow and linear, denigrate at the margin.

Hab. Brown's River, Mount Arthur.

F. lugubris, Pers.,=*P. enteromorpha*, Tayl.,=*P. physodes*, *var. enteromorpha* of Babington, generally rugulose, with narrow laciniæ spread out to a span or more.

Hab. *Brown*, Cr.; *Gunn*, *Archer*, Hook. Fl. Tasm.; Hook. L. J. Bot.; Mount Wellington.

Var. 2. *encausta*, Sw., albido cinerascent, nearly fuscescent, narrowly laciniate, unequal, laciniæ multifid, convex or terete, imbricato decumbent or depressed, under surface nigrescent, opaque. Apothecia badio rufous, margin crenulate. Spores ·007 to ·01 × ·005 to ·008 mm.

Hab. Mount Wellington.

19. *P. placorhodioides*, Nyl.,=*P. conferta*, Tayl., similar to *physodes*, but with thallus growing together as though monophyllo orbicular, thinly membranaceous, margin crenate or laciniato incised, beneath nigricant, but paler at edge or wholly albid. Apothecia much elevated, liver coloured or liver reddish, 4 to 8 mm. wide, crowded at centre of thallus. Spores ·008 to ·01 × ·005 to ·006 mm. Polymorphus, sometimes rugulose, etc., etc.

Hab., very common on trees and logs. *Oldfield*, Hook. Fl. Tasm.; Hook. L. J. Bot.; Nyl.; Huon, Brown's River, Mount Wellington, St. Mary's Pass, Launceston, Mount Arthur, Ulverstone; Tasman Peninsula, and Hobart, *Weymouth*.

20. *P. mundata*, Nyl., whitish or white, narrowly laciniate, laciniæ dichotomous, linear, 1½ to 2½ mm. broad, closely ruguloso unequal, sub-opaque, under surface black, somewhat shining, plicato corrugate, and towards apices badious or even dealbate. Apothecia pallido badious, 4 to 9 mm. broad, receptacle rugulose, elevated, base sub-podicellate, margin entire. Spores ·008 to ·009 × ·006 to ·007 mm.

Hab. on bark of trees. *Verreaux*, Nyl.; Derwent River, *Brown*, Cr.; Krplh.; Brown's River, Mount Wellington.

F. pulverata, Nyl., laciniæ somewhat broader, densely and nutely greyish-white pulverulent. Sterile.

Hab. on trees—dendrosma—in shady woods at base of Mount Wellington, *Brown*, Cr.

21. *P. pertusa*, Schrank, = *P. diatrypa*, Tayl., whitish, orbicular, plano appressed, glabrous, laciniæ narrow, multifid, sinuate, convex, somewhat shining, minutely perforated, apices dilated, crenato incised, sometimes sorediate, under surface black and rugose. Medulla K yellow C –. Apothecia rufo fuscescent, margin entire, inflexed. Spores 2 to 4, large, ·045 to ·06 × ·022 to ·028 mm.

Hab. *Brown*, Cr.; *Gunn*, Cheshunt, *Archer*, Hook. Fl. Tasm.; Brown's River, Mount Wellington, St. Mary's, St. Mary's Pass, Launceston, Mount Arthur; Blue Tier, *Simson*; Tasman Peninsula, *Weymouth* and *Bastow*.

Var. 1. *coskinodes*, Wilson, much smaller, glaucous, riddled with perforations, sometimes merely reticulate.

Hab. Mount Arthur; Tasman Peninsula, *Weymouth*.

Var. 2. *montana*, Wilson, dwarfed, generally fusco rufous or fuscous or black, laciniæ congested, convoluto undulate, perforations where usually apothecia appear, but few. Apothecia small, badio rufous or rufo fuscous, elevated, concave, margin thin, entire, back of receptacle rugose. Spores ·04 × ·025 mm.; epispore thick, like that of a pertusaria.

Hab. on twigs of shrubs at summit of Mount Wellington.

22. *P. reticulata*, Tayl., Hook. L. J. Bot. Description in Tayl. Flor. Hiber.

23. *P. angustata*, Pers., = *P. inequalis*, Tayl., = *P. moniliformis*, Bab., yellowish, sub-opaque, or rather shining, suborbicular, lineari laciniate, laciniæ 1 mm. wide or less, multifid, plane or convex, imbricate or sub-imbricate, often moniliformi constricted, apices attenuate, under surface either continuously or interruptedly spongy, fuliginous or fusco badious, upper surface sprinkled with minute white glandulose papillæ, visible with lens. Apothecia spadiceous, or badio fuscescent, moderate or largish, elevated and spongy at the sides, margin at length lobato unequal. Spores somewhat spherical, ·005 to ·007 × ·004 to ·005 mm.

Hab. Grass Tree Hill, *Hooker*, Cheshunt, *Archer*, Hook. Fl. Tasm.; Mount Wellington, Mount Arthur, St. Mary's Pass.

24. *P. colpodes*, Ach., whitish, sub-stellate, 1 to 2 inches wide, laciniæ 1 mm. broad, lineari multifid, rather plane, apices often 2 to 3 crenate, under surface fuligineo pannose. Apothecia spadiceo rufescent, 2 to 5 mm. wide, margin nude, entire or slightly rugulose. Spores oblong, ·0025 × ·001 mm.

Hab. Mount Wellington, Mount Arthur; Tasman Peninsula, *Weymouth*.

10. THELOSCHISTES.

Thallus laciniate, generally stellato orbicular. Apothecia orange or yellow. Spores colourless, polari bilocular.

1. *T. flavicans*, Sw., yellow or orange-yellow, cæspitose, subterete, slender, entangled, much branched, branches attenuate, furcellate at apices. Apothecia orange or rufous orange, margin thin, sub-entire. Spores elliptico oblong, ·012 to ·018 × ·007 to ·011 mm.

Hab. B. v. M., Vic. Nat., 1887, Oct.

Var. subexilis, Nyl., = *Physcia subexilis* of Crombie, smaller, cæspitose, orange-yellow throughout. Apothecia saffron orange, 1 to 2 mm. wide, thalline margin at length excluded. Spores ·011 to ·015 × ·006 to ·008 mm.

Hab. on rocks, Kent Island, *Brown* Cr.; B. v. M., Vic. Nat., 1887, Oct.

2. *T. chrysophthalmus*, L., yellow or flavo albicant, or flavo cinerascent, rigescent narrowly laciniate, laciniæ ascending, divaricato multifid, apices filbriloso ramulose or spinose, whitish beneath. Apothecia orange, margin filbriloso ciliate, sometimes naked. Spores elliptico oblong, ·011 to ·017 × ·006 to ·01 mm.

Var. Sieberi, Mull. Arg., = *Parmelia spinosa* of Taylor.

Hab. on basaltic rocks, George Town, *Gunn*, Hook, Fl., Tasm.; Hook. L. J. Bot.; Krplh.; Launceston.

3. *T. velifer*, Wilson, yellow, or in the sun orange, ½ inch or less broad, sociable, laciniolate, laciniæ somewhat convex, beneath albid, sub-canaliculate, with concolorous ciliæ, the apices ascending, elongate, applanate, inflated, with their lower cortex and the medulla usually wanting, and often exposing copious green or yellow gonidia. Apothecia orange rufous, 1 to 2 mm. broad, at length sub-cephaloid, much elevated, 1 to 2 mm. high, arising from the base of the thalline apical lobes. Spores ·01 × ·008 mm. bilocular, the locules united by medial tube.

Hab. on bark of trees and bushes, sterile. Launceston.

4. *T. parietinus*, L., yellow, sub-orbicular, membranaceous, rotundato lobate, incised, lobes sub-imbricate, appressed, plane or sub-concave, smooth, margin crenate, thickened and upturned, under surface paler or whitish. Apothecia concolorous or waxy orange, margin entire. Spores ·01 to ·016 × ·007 to ·009 mm.

Hab. on trees and rocks. *Gunn*, St. Patrick's, *Oldfield*, Cheshunt, *Archer*, Hook. Fl. Tasm.; Hmpe.; Krplh.; Brown's River, Hobart, Falmouth, Launceston, Mount Wellington; and Cornelian Bay and Bellerive, *Bastow*; Derwent River, *Weymouth*.

Var. lychnea, Ach., orange coloured, pulvinate, crowded rotundo squamulose, adscendenti imbricate, margins granuloso pulverulent or lacero dissect. Apothecia margin entire, pulverulent.
Hab. Domain, Hobart.

11. PHYSCIA, Nyl.

Thallus laciniate, usually stellato orbicular. Apothecia lecanorine, nigricant. Spores fuscous, 1 septate.

1. *P. speciosa*, Wulf., white or albo cinerascent, stellato laciniate, laciniæ narrow, multifid, plane, sub-imbricate, somewhat ascending at the apices, under surface plane, albo floculose, rhizinæ and marginal ciliæ whitish. Medulla Ky Cy. Apothecia fuscous, margin sub-entire or crenulate, incurved. Spores ·025 to ·036 × ·012 to ·017 mm.
Hab. Hmpe.; Krplh.; Mount Wellington.

F. sorediata.
Hab. Brown's River.

2. *P. comosa*, Nyl, white or albo cinerascent or albo glaucescent, laciniato divided, laciniæ rather short, ascending, ciliæ scattered and on margin, under surface pure white. Apothecia cæsio pruinose, 3 to even 13 mm. wide, elevated, receptacle podicellate, sprinkled with ciliæ, margin thin and broad. Spores ·024 to ·03 × ·012 to ·017 mm.
Hab. B. v. M., Vic. Nat., 1887, Oct.

3. *P. stellaris*, L., white or albo glaucescent, orbicular, stellari appressed, laciniæ multifid, contiguous, sub-cortically albo maculate, under surface whitish, with concolorous or fuscescent or nigricant fibrillæ. Med. K yellow C —. Apothecia fuscous black or black, naked or cæsio pruinose, margin entire or obsoletely crenulate. Spores oblong, cells nucleated, ·016 to ·024 × ·008 to ·011 mm.
Hab. on trees, St. Mary's, Launceston.

4. *P. astroidea*, Clem., greyish white, orbicular, thin, closely appressed, almost entirely granulose or leprose, laciniato effigurate at the circumference. Med. Ky Cy. Apothecia fuscous black, naked or pruinrose. Spores elliptico oblong, cells nucleated, ·017 to ·026 × ·008 to ·011 mm.
Hab. on trees, St. Mary's Pass.

5. *Physcia picta*, Sw., white or whitish, appressed, orbicular, laciniæ plane, sub-imbricate, contiguous or sub-confluent, narrow, variously crenate, under surface black, nude, opaque, but at extreme edge whitish. Apothecia black, plane, small,

1¼ mm. wide, black within, receptacle rather elevated and margin crenulate. Spores ·011 to ·02 × ·007 to 009 ·mm.

Hab. B. v. M., Vic. Nat., 1887, Oct. Very doubtful. *P. picta* is a strictly tropical and sub-tropical lichen. It has not been found in Victoria.

12. UMBLICARIA.

Thallus membranaceous, monophyllous, umblically affixed. Apothecia lecideine, complicato compound or gyrose. Paraphyses distinct. Spermatia slender, shortly cylindrical, obtuse at both apices.

1. *U. cylindrica*, L., cinerascent or dull greenish brown, thickish, unequally lobed, margins nigro fibrilloso ciliate, upper surface rugulose, under surface pallescent, more or less fibrillose. Med. K — C —. Apothecia concentrico gyrose, podicellate. Spores 8, colourless, ellipsoid, simple, ·01 to ·016 × ·006 to ·008 mm.

Hab. on sub-alpine rocks, summit Mount Wellington (and *Brown*, Cr.).

F. jubata, Wilson, black, filiform, cæspitose, elongate. entangled.

Hab. with type, Mount Wellington.

2. *U. atro-pruinosa*, Schær, *var. cinerascens*, Ach., fusconigricant somewhat cinerascent, smooth, or at the centre very thinly rimuloso areolate, under surface fuligineo nigricant, or, especially towards the margin, cinereous and shining. Apothecia somewhat prominent, simply lecideine, moderate. Spores simple, ellipsoid, often bean-shaped, ·011 to ·016 × ·006 to ·009 mm.

Hab. on rocks at summit of Mount Wellington. Associated with *U. cylindrica*, but on more exposed parts of the rocks.

3. *U. proboscidea*, L., cinereo nigrescent, thin, crenate, slightly lobed, pale pruinose, grey in the centre, where it is marked with elevated reticulated veins, the other portions rugose, under surface smooth, cinereo pallescent, Med. K — C red. Apothecia gyroso plicate. Spores 8, colourless, ellipsoid, simple.

Hab. Mount Wellington, *Brown*, Cr.

A LIST OF THE KNOWN LICHENS OF TASMANIA.

By John Shirley, B. Sc., Queensland.

In preparing this paper the following works have been consulted:—Babington's "Lichens of Tasmania," in Hooker's flora of the island, by a most accurate and painstaking lichenologist, many of whose names are now obsolete from changes of classification: "Hooker's Journal of Botany for 1844 and 1847," containing descriptions of all lichens named by J. D. Hooker and T. Taylor, also the "Botany of the Antarctic Voyage of H.M. ships Erebus and Terror." Few of the names given by Hooker and Taylor are now employed, as they are mainly synonyms of lichens previously described by older collectors: the Rev. J. M. Crombie's paper on the lichens of Robert Brown's herbarium, published in the Journal of the Linnæan Society, Vol. xvii., 1879, pp. 390-401; a sound and valuable contribution: "Exotische Flechten aus dem Herbax des K. K. botanischen Hofkabinetes in Wien," and "Ein neuer Beitrag Zur Flechten Flora Australiens," by Dr. A. v. Krempelhüber, whose names, like those of Hooker and Taylor, have almost wholly lapsed: numerous "Lichenologische Beiträge," of Dr. Jean Müller, of Geneva, the most eminent lichenologist of the day; Dr. W. Nylander's "Synopsis Methodica Lichenum"; and Baron F. v. Müeller's lists of Australian lichens, in "Fragmenta Phytographiæ Australiæ," Vol. xi., and the Victorian Naturalist, Vol. iv., pp. 88-95.

The classification is that of Dr. Jean Müller, and the reference following the name of each species is the authority by which the plant is regarded as Tasmanian.

Order I.—Ephebaceæ (Nyl.) *Cromb.* (Epebacei in Grevillea. Vol. , p.).

Tribe I.—Ephebeæ (Nyl.) *Cromb.* (Ephebei in Grerellea, Vol. p.).

Genus 1.—Ephebe, *Fries.*

1. Ephebe tasmanica, *Cromb.*, Lich., R. Brown's Herb., No. 522 (b).
2. „ pubescens, *Ach.* „ „ „ „ No. 522 (a).

ORDER II.—COLLEMACEÆ, *Mull.* Arg. Enum. Lich. Genere p. 18, an Lich. Socot.

TRIBE II.—COLLEMEÆ, *Körb.*, Par. p. 408.

Genus 2.—Leptogium (Fr.), *Nyl.*

1. Leptogium tremelloides, *Fries*, Fl. Tasm., p. 353.

Genus 3.—Synechoblastus (Trer.), *Körb.*

1. Synechoblastus lencocarpus, *Mull.* Arg., s. Collema lencocarpum. *Tayl.*, Lich., R. Brown, No. 549 (b), Fl. Tasm., p. 353.
2. „ nigrescens (Trev.), *Auzi.*, s. Collema nigrescens, *Huds.*, Lich., R. Brown, No. 549 (a).
3. „ implicatus, *Mull. Arg.*, s. Collema implicatum, *Nyl.* Lich., R. Brown, No. 511.
4. „ fascicularis, *Mull. Arg.*, s. Collema aggregatum, *Nyl.*, and C. thysanæum, *Moug.*, Fl. Tas., p. 353.
5. „ flaccidus (Ach.), *Körb.*, s. C. flaccidum, *Ach.*, Fl. Tas., p. 353.

Genus 4.—Ramalodium, *Nyl.*

1. Ramalodium succulentum (R. Br.), *Nyl.*, Lich., R. Brown, No. 551.

TRIBE III.—PYRENOPSIDEÆ, *Th. M. Fries.*, Lich. Arct., p. 284.

Genus 5.—Pyrenopsis, *Nyl.*

1. Pyrenopsis tasmanica, *Nyl.*, Fl. Tasman., p. 353.

ORDER III.—LICHENACEÆ, *Mull. Arg.*, Lich. Socot., s. Eulichenes and Enum., Lich. Genère, p. 18.

TRIBE IV.—SPHÆROPHOREÆ, *Fr.*, Lich., Europ., p. 403.

Genus 6.—Sphærophoron, *Pers.*

1. Sphærophoron compressum, *Ach.*, Fl. Tasm., p. 355.
2. „ australe, *Laur.*, Lich., R. Brown, No. 517, Fl. Tas., p. 352.
3. „ coralloides, *Pers.*, Lich., R. Brown, No. 5 ', Fl. Tas., p. 352.
4. „ tenerum, *Laur.*, Fl. Tasman., p. 352.

TRIBE V.—BÆONUFCEÆ, *Mull. Arg.*, Lich., Cathar., 7.

Genus 7.—Bæonufces, *Pers.*

1. Bæonufces roseus, *Pers.*, Fl. Tasman., p. 351.
2. „ heteromorphus, *Nyl.*, Fl. Tasman., p. 351.
3. „ squamarioides, *Nyl.*, s. B. splanchnirima, *Mitt.*, Knightiella lencocarpa, *Mull. Arg.*, K. squamarioides, *Mull. Arg.*, Fl. Tasman., p. 351.

TRIBE VI.—CLADOMEÆ, *Mull. Arg.*, Lich. Genère, p. 22.

Genus 8.—Stereocaulon, *Schres.*

1. Stereocaulon ramulosum, *Ach.*, Lich., R. Brown, No. 526, Fl. Tasm., p. 349, s. R. proximum, *Krph.*, Fl. Aus., 29.
   „ ramulosum, v. macrocarpum, *Bab.*, Nyl., Syn. i., 236.
2. „ proximum, *Nyl.*, s. R. ramulosum, *Kremp.*, Flecht. Fl. Aus., 30.
   „ proximum, v. microcarpoides, *Nyl.*, Syn. i., 238.
3. „ coralloides, *Fr.*, s. S. corallinum, *Fr.*, Fl. Tasm., p. 349.
4. „ denudatum, *Pers.*, s. S. assimile, *Nyl.*, S. mixtum, v. denudatum, *Pers.*, Fl. Tasm., p. 349.
5. „ leptaleum, *Nyl.*, Syn. i., 250.
6. „ gracilescens, *Nyl.*, Fl. Tasm., p. 349.

Genus 9.—Siphula, *Fr.*

1. Siphula torulosa, *Thunb.*, Lich., R. Brown, No. 501.

Genus 10.—Clathrina, *Mull. Arg.*

1. Clathrina retipora, *Mull. Arg.*, s. Cladonia retipora, *Flk.*, Fl. Tasm., p. 350.
2. „ aggregata, *Mull. Arg.*, s. Cladonia aggregate, *Eschw.*, Fl. Tasm., p. 350.
3. „ schizopora, *Mull. Arg.*, s. Cladonia schizopora, *Nyl.*, Syn. i., 217.

Genus 11.—Cladonia, *Hffm.*

SECTION A.—ASCYPHÆ.

1. Cladonia rangiferina, *Hffm.*, Fl. Tasm., p. 350.
   „ „ v. alpestris, *L.*, s. C. sylvatica, v. sylvestris, *L.*, Kremp., Exot. Flecht., 26.
   „ rangiferina, v. sylvatica, *Hffm.*, Fl. Tas., p. 350, Lich. R. Br., 527.

2. Cladonia squamosa, *Hffm.*, Fl. Tasman., p. 350, s. C. sparassa, *Ach.*, Hook. IV., 651.

„ squamosa, v. acuminata, *Ach.*, s. C. acuminata, *Ach.*, Lich. R. Br., 531.

3. „ furcata, *Hffm.*, Fl. Tasman, p. 350.

„ „ v. adspersa, *Flk.*, s. C. adspersa, *Flk.*, Lich. R. Br., 535.

„ furcata, v. asperata, *Mull. Arg.*, Lich. Beit., 381.

4. „ amaurocræa, *Sch.*, s. C. capitellata, *Bab.*, Fl. Tasm., p. 350.

5. „ ceratophylla, *Eschw.*, F. v. M., Vict. Nat., IV., 89.

SECTION B.—SCYPHOPHORÆ. Paeshcarpæ.

6. Cladonia pyxidata, *Fries.*, Fl. Tasman. p. 350.

7. „ cariosa, *Flk.*, Nyl., Syn., I., 194.

8. „ fimbriata, *Hffm.*, Fl. Tasm., p. 350.

„ „ v. adspersa, *Tuck.*, s. C. squamosa. f. cylindrica, *Kremp.*, Flecht. Flor. Aus., 17.

„ „ v. radiata, *Fr.*, Fl. Tas., p. 350, s. v. cornuta.

„ „ v. caniocrata, *Del.*, Fl. Tas., p. 350.

9. „ verticilata, *Flk.*, Fl. Tasm., p. 350.

10. „ cervicorrils, *Sch.*, Kremp. Fl. Aus., 16.

11. „ decorticata, *Fr.*, Fl. Tasm., p. 350.

12. „ degeneraus, *Flk.*, Fl. Tasm., p. 350.

SECTION C.—SCYPHOPHORÆ-ERYTHROCARPÆ.

13. „ cornucopioides, *Fr.*, s. C. deformis, v. Tasmanica, *Krph.*, Flecht., Fl. Aust., 4, Fl. Tasm., p. 351.

„ cornucopioides, v. extensa, *Sch.*, s. C. firma, *Laur*, Kremp. Ex. Fl., 36.

14. „ deformis, *Hffm.*, Lich., R. Br., No. 530, Fl. Tasm., p. 351.

15. „ digitata, *Hffm.*, Fl. Tasm., p. 351.

16. „ macilenta, *Hffm.*, Fl. Tasm. p. 351.

„ „ v. seductrix, *Nyl.*, Syn., p. 225.

17. „ floerkeana, *Fr.*, Fl. Tasm., p. 351.

TRIBE VII.—THAMNOLIEÆ, *Mull. Arg.*, Lich. Merjosh, 28.

Genus 12.—Thamnolia, *Ach*,

1. Thamnolia vermicularis, *Sch.*, Lich., R. Brown, No. 528.

TRIBE VIII.—HETERODEÆ, *Mull. Arg.*, Heterodei, *Nyl.* Fueg. Pat., p. 30.

Genus 13.—Heterodea, *Nyl.*

1. Heterodea muelleri, *Nyl.*, Syn. I., 306.

TRIBE IX.—USNEÆ *Mull. Arg.*, Bot. Socot., p. 349, and Th. M. Fries. Gen. Heterol., p. 47.

Genus 14.—Usnea, *Hffm.*

1. Usnea barbata, *Fr.*, Fl. Tas., p. 344.
„ „ v. scabrida, *Tayl.*, Fl. Tas., p. 344.
„ „ v. ceratina, *Sch.*, Cromb. Lich., R. Brown, No. 518 (b)
„ „ v. florida, *Fr.* „ „ „ „ No. 518 (a)
„ „ v. hirta, *Ach.*, *Kremp.*, Flecht. Fl. Aus., 31.
„ „ v. tasmanica, *Mull. Arg.*, Lich. Beit., 391.
2. „ plicata, *Hffm.*, Kremp., Flecht. Exot., 62.
3. „ dasypogoides, *Nyl.*, s. U. straminea, *Mull. Arg.* Lich. Beit., 96 and 1477.
4. „ angulata, *Ach.*, Fl. Tas., p. 344.

Genus 15.—Neuropogon, *Nees et Flot.*

1. Neuropogon melaxanthus (Ach.), *Nyl.*, Lich., R. Brown, No. 523, and Fl. Tasm., p. 344.

TRIBE X.—RAMALINEÆ, *Mull. Arg.*, Bot., Socot., p. 350, and Th. M. Fries., Gen. Theterol., p. 50.

Genus 16.—Ramalina (Ach.), *Fr.*

1. Ramalina calicaris, *Fr.*, Fl. Tasman., p. 344.
2. „ pusilla, *Le Preur.*, Fl. Tasman., p. 344.
3. „ inflata, *Hook.*, v. gracilis, *Mull. Arg.*, s. R. geniculata, *Tayl.*, Flecht., Fl. Aus., 41.
4. „ Ecklonii v. ovalis, *Mull. Arg.*, s. R. calicaris B. ovalis., *Bab.*, Fl. Tas., p. 344.

Genus 17.—Evernia (Ach.), *Nyl.*

1. Evernia furfuracea, *Mann.*, Fl. Tasman., p. 344.

TRIBE XI.—PELTIGEREÆ, *Mull. Arg.*, Lich. Genère, p. 29

Genus 18.—Peltigera (Ach), *Hffm.*

1. Peltigera polydactyla, *Hffm.*, Fl. Tasm., p. 344.
„ „ v. dolichorhiza, *Nyl.*, Kremp Flecht. Fl. Aus. 50.
2. „ horizontalis, *Hffm.*, Fl. Tasm., p. 344.

3. Peltigera rufescens, *Hffm.*, v. spuria D. c. s. P. canina, v. pusilla, *Körb.*, and P. spuria, D.C. Fl. Tas., p. 345, and Nyl. I., 325.
 „ rufescens, f. membranacea, *Ach.*, Lich., R. Brown, No. 510.

Genus 19.—Nephroma, *Nyl.*

1. Nephroma Australie, *A. Rich.*, Fl. Tasm., p. 345.

Genus 20.—Nephromium, *Nyl.*

1. Nephromium cellulosum, *Nyl.*, Lich., R. Brown, No. 543. Fl. Tas., p. 345.

TRIBE XII.—GYROPHOREÆ, *Mull. Arg.*, Lich. Genère, p. 29.

Genus 21.—Gyrophora, *Ach.*

1. Gyrophora cylindrica, *D.C.* Lich., R. Brown, No. 558.
2. „ proboscidea, *Ach.* „ „ „ „ 559.

TRIBE XIII.—PARMELIEÆ, *Mull. Arg.*, Lich. Genere, p. 31 and Lich. Parag., p. 3.

Genus 22.—Stictina, *Nyl.*

SECTION A.—CYPHELLATÆ.

1. Stictina filicina (Ach.), *Nyl.*, Fl. Tas., p. 345.
 „ „ v. latifrons, *Rich.*, s. S. latifrons, *Rich.*, Fl. Tas., p. 345.
2. „ guercizans, *Nyl.*, Syn. I., 344.
3. „ fuliginosa, *Nyl.*, Fl. Tasm., p. 346.

SECTION B.—PSEUDOCYPHELLATÆ-ALBÆ,

4. „ fragillima, *Nyl.*, v. dissecta, *Mull. Arg.*, s. S. fragillissima, *Krph.*, F. v. M., Vic. Nat., IV., 90; Mull. Arg., L.B. XXV., Sup.
 „ fragillima, v. dissimilis, *Nyl.*, s. S. dissimilis, *Nyl.*, and S. Cinnamomea, *Rich.*, Mull. Arg., Lich. Beit., 561.
5. „ faveolata, *Nyl.*, i., 337, Fl. Tasm., p. 346.

SECTION C.—PSEUDOCYPHELLATÆ FLAVÆ.

6. Stictina crocata, *Nyl.*, s. Sticta crocata, *L.*, Fl. Tasm., p. 345, Lich., R Br., 540.
 „ crocata, v. gilva, *Nyl.*, Syn., I., 339.

7. Stictina carpoloma (Del.), *Nyl.*, Lich., R. Brown, No. 540 (b).
   „ carpoloma, v. granulata, *Nyl.*, s. S. Granulata, *Bab.*, Fl. Tas., p. 346.

Genus 23.—Sticta, *Ach.*

SECTION A.—ECYPHELLATÆ.

1. Sticta scrobiculata, *Scop.*, Lich., R. Brown, No. 541.

SECTION B.—CYPHELLATÆ.

2. Sticta damæcornis, *Ach.*, v. subcaperata, *Nyl.*, s. S. subcaperata, *Nyl.*, Lich., R. Brown, No. 555.

SECTION C.—PSEUDOCYPHELLATÆ-ALBÆ.

3. Sticta dissimulata, *Nyl.*, v. multifida, *Laur.*, s. S. multifida, *Laur.*, Lich., R. B., 516.
4. „ fossulata, *Duf.*, Nyl., Syn., I., 363, and Lich., R. Br., No. 536.
5. „ billardieri, *Del.*, s. S. fossulata, *Krph.*, Flecht. Fl. Aus., 74, and S. Richardi, *Mut.*, *fide* Mull. Arg., Lich., Beit., 566, 1304-5, Fl. Tasm., p. 346.
6. „ polificans, *Nyl.*, F. v. M., Vic. Nat., IV., 90.
7. „ subrariabilis, *Nyl.*, F. v. M., Vic. Nat., IV., 90.
8. „ freycinetii, *Del.*, Lich., R. Brown, No. 538, Fl. Tasman., p. 346.
   „ freycinetii, v. Prolifera, *Mull. Arg.*, Lich., Beit. 565, 1301.
9. „ cetrarioides, *Bab.*, Fl. Tasm., p. 346.

SECTION D.—PSEUDOCYPHELLATÆ-FLAVÆ.

10. Sticta endochrysea, *Del.*, v. Urvillei, *Mull. Arg.*, s. S. Urvillei, *Nyl.*, F. v. M., Vic. Nat., IV., 90.
    „ endochrysea, v. Colensoi, *Bab.*, s. S. Colensoi, *Bab.*, Fl. Tasm., p. 345, Kremp., Flecht. Fl. Aus., 68.
11. „ orygmæa, *Ach.*, Fl. Tasman., p. 345.
12. „ aurata, *Ach.*, „ „ „
13. „ fragilis, *Mull. Arg.*, s. Endocarpon fragile, *Tayl.*, Fl. Tasman, p. 353.

Genus 24.—Ricasolia, *De Not.*

1. Ricasolia laete-vireus, *Lghtf.*, s. R. herbacea, *Nyl.*, Fl. Tas., p. 346.
   „ laete-vireus, v. Sieberianus, *Mull. Arg.*, Lich., Beit., 581.

2. Ricasolia patinifera, *Mull. Arg.*, s. R. sublævis, *Nyl.*, and R. crenulata, *Kremp.*, Flecht. Flor. Aus., 76.

Genus 25.—Parmelia (Ach), *Nyl.*

SECTION A.—HYPORHIZIÆ-GLAUCESCENTES.

1. Parmelia perlata, *Ach.*, Fl. Tasm., p. 346.
2. „ perforata, *Ach.*, s. P. reticulata, *Tayl.*, Hook. Jour. Bot, IV., 644.
„ perforata, v. ulophylla, *Meyes Flos.*, s. P. concors., *Krph.*, Flecht. Fl. Aus., 79.
3. „ laceratula, *Nyl.*, s. P. subflara, *Tayl.*, Hook. Jour. Bot., 1847, p. 174.
4. „ tenuirema, *Tayl.*, Lich., R. Brown, No. 537, Hook. Jour. Bot., 1844, p. 645.
5. „ tiliacea, *Ach.*, Fl. Tasman., p. 347.
6. „ saxatilis, *Ach.*, Fl. Tasman., p. 347.
„ „ v. laevis, *Nyl.*, *Kremp.*, Exot. Flecht., 127.

SECTION B.—HYPORHIZÆ-FLAVESCENTES.

7. Parmelia adpressa, *Krph.*, s. P. amplexula, *Stirton*, F. v. M., Vic. Nat., IV., 90.
8. „ conspersa, *Ach.*, Fl. Tasman., p. 347.
„ „ v. laxa, *Mull. Arg.*. s. P. tasmanica and P. incisa, *Tayl.*, Hook. Jour. Bot., 1844, p. 644.
9. „ caperata, *Ach.*, Fl. Tasman., p. 347.
10, „ subcaperatula, *Nyl.*, Lich., R. Br., No. 539.
11, „ rutidola, *Hook. f. et Tayl.*, Hook. Jour. Bot., 1844, p. 645.

SECTION C.—OLIVACEÆ.

12. „ prolixa, *Nyl.*, Syn., I., 396.
13. „ olivacea, *Ach.*, Fl. Tasman., p. 347.
14. „ lanata, *Nyl.*, Lich., R. Brown, No. 521.

SECTION D.—HYPOGYMNIÆ.

15. Parmelia australiensis, *Cromb.*, s. P. convoluta, *Krph.*, Lich., R. Br., 525 (a.)
16 „ pertusa, *Schrank*, s. P. diatrypa, *Ach.*, Lich., R. Brown, 514 (b.), and Fl. Tasm., p. 347.

17. Parmelia physodes, *Ach.*, Fl. Tasman, p 347.
  - „ physodes, v. lugubris (Pers), *Nyl.*, Lich., R. Brown, No. 526.
  - „ physodes, v. sublugubris, *Mull. Arg.*, Lich. Beit., 577.
  - „ physodes, v. placorhodioides, *Nyl.*, Fl. Tas., p. 347, Lich., R. Br., No. 514 (a), s. P. conflerta, *Tayl.*, Hook. Jour. Bot., 1847, p. 164.
  - „ physodes, v. mundata, *Nyl.*, Lich., R. Brown, No. 515 (a).
  - „ physodes, v. „ f. pulverata, *Nyl.*, Lich., R. Brown, No. 550, s. P. sulphysodes, *Krph.*, Flecht. Fl. Aus., 80.
  - „ physodes, v. enteromorpha, *Tuck.*, s. P. enteromorpha, *Ach.*, Hook. Jour. Bot., IV., 643.

Genus 26.—Auzia, *Mull. Arg.*

1. Auzia angustata, *Mull. Arg.*, s. Parmelia moniliformis, *Bab.*, Fl. Tas., p. 347, v. Lich., R. Brown, No. 515 (b), s. P. inequalis, *Tayl.*, Hook. Jour. Bot., 1847, p. 169.

Genus 27.—Theloschistes, *Norm.*

1. Theloschistes chrysophthalmus, *Th. Fr.*, s. Physcia chrysophthalma, *L.*, Lich., R. Brown, No. 545, Fl. Tasm., p. 348.
  - „ chrysophthalmus, v. Sieberianus, *Mull. Arg.*, s. P. spinosa, *Hook. et Tayl.*, Hook. Jour. Bot. 1844, p. 644.
2. „ flavicans, *Norm.*, s. P. flavicans, *Sw.*, F. v. M., Vic. Nat., IV., 91.
3. „ parietinus, *Norm.*, s. P. parietina, *L.*, Fl. Tas., p. 348.
4. „ subescilis, *Nyl.*, s. P. subescilis, *Nyl.*, Lich., R. Br., No. 545 (b).

Genus 28.—Anaptychia, *Körb.*, Syst., p. 50.

1. Anaptychia comosa, *Trer.*, s. Physcia comosa, *Nyl.*, F. v. M., Vic. Nat., IV., 91.

Genus 29.—Physcia, *Nyl.*

1. Physcia picta, *Nyl.*, F. v. M., Vic. Nat., IV., 91.

TRIBE XIV.—PANNARIEÆ, *Körb.*, Syst., p. 105.

Genus 30.—Pannaria, Del.

1. Pannaria rubiginoso, *Del.*, Lich., R. Brown, No. 555.
2. „ rubiginascens, *Nyl.*, Lich., R. Brown, No 512.
3. „ fulvescens, *Nyl.*, F. v. M., Vic. Nat., IV., 91.
4. „ imbricata, *Nyl.*, Fl. Tas., p. 348.

TRIBE XV.—PARMELIELLEÆ, *Mull. Arg.*, Lich., Spegaz., p. 39.

Genus 31.—Parmelliella, *Mull Arg.*

1. Parmeliella triptophylla, *Mull. Arg.*, s. Pannaria triptophylla, *Ach.*, Fl. Tas., p. 348.
2. „ nigro-cincta, *Mull. Arg.*, s. P. nigro-cincta, *Mut.*, Fl. Tas., p. 348, Lich., R. Brown, No. 508.

TRIBE XVI.—PSOROMEÆ, *Mull. Arg.*, Lich., Spegaz., p. 39.

Genus 32.—P. Soroma (Fr.), *Nyl.*

1. Psoroma sphinctrinum, *Nyl.*, Lich., R. Brown, No. 533 (a), Fl. Tasm., p. 348.
   „ sphinctrinum, v. leprolema, *Nyl.*, Lich., R. Brown, No. 533 (b).
2. „ pholidotum, *Mull. Arg.*, s. Pannaria pholidota, *Nyl.*, P. soroma soccatum, *R. Br.*, Lich., R. Brown, No. 502.
3. „ asperellum, *Nyl.*, Lich., R. Brown, No. 547.
4. „ hypnorum (Hffm.), *Nyl.*, Lich., R. Brown, No. 554.

Genus 33.—Chondropsis, *Nyl.*

1. Chondropsis semiviridis, *Nyl.*, Lich., R. Brown, No. 525 (b).

TRIBE XVII.—PLACODIEÆ, *Mull. Arg.*, Lich. Genère, p. 37.

Genus 34.—Placodium, *Mull. Arg.*

1. Placodium rugolosum, *Nyl.*, Fl. Tasman., p. 348.
2. „ fulgeus, *D.C.* „ „ „ 349.
3. „ gelidum, *Körb.*, s. Squamaria gelida, *Linn.*, Fl. Tasm., p. 349.

Genus 35.—Amphiloma, *Fr.*

1. Amphiloma murorum, *Körb.*, F. v. M., Vict. Nat., IV., 92.

TRIBE XVIII.—PSOREÆ, *Mull. Arg.* (P. sorei, Th. M. Fries, Gen. Steterolich, p. 79), Lich., Parag., p. 8.

Genus 36.—Psora, *Mull. Arg.*

1. Psora parvifolia, *Mull. Arg.*, s. Lecisea parvifolia, *Nyl.*, F. v. M., Vic. Nat., IV., 94, Lich., R. Br., No. 552.
2. „ discipieus, *Hffm.*, s. Lec. decipieus, *Ehrb.*, Lich., R. Brown, No. 567.
3. „ crystallifera, *Mull. Arg.*, s. L. crystallifera, *Tayl.* Lich., R. Br., No. 564.

TRIBE XIX.—LECANOREÆ, *Mull. Arg.*, Bot. Socot., p. 359.

Genus 37.—Lecanora, *Ach.*

1. Lecanora (Eullcanora) subfusca, *L.*, Fl. Tasman., p. 349.
2. „ „ sordida, *Fr.*, Fl. Tasman., p. 349.
3. „ „ glaucoma, *Hffm.*, Fl. Tasm., p. 349.
4. „ (Ochrolechia) pallescens, *Ach.*, Fl. Tasman., p. 349.

Genus 38.—Callopesnia, *De Not.*

1. Callopesnia cinnabarina, *Mull. Arg.*, Fl. Tasman., p. 352.

Genus 39.—Pertusaria, *D.C.*

1. Pertusia leioplaca, *Sch.*, F. v. M., Vic. Nat., IV., 93.
   „ „ v. octospora, *Nyl.*, Mull. Arg., Lich., Beit., 743.
2. „ gibberosa, *Mull. Arg.*, Lich., Beit., 503.

Genus 40.—Urceolaria, *Ach.*

1. Urceolaria subocellata, *Nyl.*, Lich., R. Brown, No. 563.
2. „ scruposa, *Ach.*, s. Lecanora scruposa, Fl. Tas., p. 349.

TRIBE XX.—GYALECTEÆ, *Mull. Arg.*, Lich., Parag. p. 12.

Genus 41.—Gyalecta (Ach.), *Mull. Arg.*

1. Gyalecta cupularis, *Smmrf.*, Fl. Tasman., p. 349.

TRIBE XXI.—LECIDEÆ, *Mull. Arg.*, Lich., Genère, p. 50.

Genus 42.—Lecidea (Ach.), *Mull. Arg.*

1. Lecidea immarginata, *R. Br.*, Lich., R. Br., No. 591.
2. Lecidea flindersii, *Cromb.*, Lich., R. Brown, No. 565.
3. „ leptocarpa, *Nyl.*, Fl. Tas., p. 352.
4. „ stuartii (Hampe), *Nyl.*, Fl. Tasm., p. 352.

Genus 43.—Patellaria (Hffm.), *Mull. Arg.*

1. Patellaria grossa (Pers.), *Mull. Arg.*, s. Lec. grossa, *Pers.*, F. v. M., Vic., Nat., IV., 92.
2. „ marginiflexa, *Mull. Arg.*, s. Biatora marginiflexa, Fl. Tas., p. 352.
3. „ versicolor, *Mull. Arg.*, s. Lec. versicolor, *Fee.*, L. diachroma, *Fee.*, L. obturgesceus, *Krph.*, L. glaucesceus, *Krph.*, Lich., R. Br., No. 548.

Genus 44.—Blastenia, *Mull. Arg.*

1. Blastenia ferruginea (Huds.), *Mull. Arg.*, s. Lec. ferruginea, *Huds.*, Lich., R. Brown, No. 503.
   „ ferruginea f. crenularia, *With.*, Lich., R. Brown, No. 503.

Genus 45.—Buellia (De Not.), *Mull. Arg.*

1. Buellia atro-alba (Ach.), *Luck.*, s. Lec. atro-alba, *Ach.* Fl. Tas., p. 352.
2. „ parmeliarum, *Smmrf.*, s. Abrothallus smithii *Lul.*, Fl. Tas., p 354.

Genus 46.—Rhizocarpon (Körb.), *Mull. Arg.*

1. Rhizocarpon petræum, *Körb.*, s. Lec. petræa, *Wolf.*, Fl. Tas , p. 352.
2. „ petræoides (Nyl.), *Mull. Arg.*, s. Lec. petræoides, *Bab.*, Fl. Tas., p. 352.

Genus 47.—Heterothecium (Fl.), *Mull. Arg.*

1. Heterothecium biferum, *Mull. Arg.*, s. Lec. bifera, *Nyl.* F. v. M., Vic., Nat., IV., 91.

TRIBE XXII.—BIATORINOPSIDEÆ, *Mull. Arg.*, Lich., Parag., p. 18.

Genus 48.—Biatorinopsis, *Mull. Arg.*

1. Biatorinopsis lutea, *Mull. Arg.*, s. Lec. lutea, *Dcks.*, Lich., R. Br., 529, Fl. Tasman., p. 352.

TRIBE XXIII.—COLNOGONIEÆ, *Mull. Arg.*, Lich., Parag., p. 18.

Genus 49.—Cœnogonium, *Ehrenb.*

1. Colnogonium Linkii, *Ehrenb.*, Fl. Tas., p. 353.
2. „ implexum, *Nyl.*, Lich., R. Brown, No. 504.

TRIBE XXIV.—THELOTREMEÆ, *Mull. Arg.*, Graph., Fee, pp. 3, 15.

Genus 50.—Thelotrema, *Mull. Arg.*

1. Thelotrema lepadinum, *Ach.*, Lich., R. Brown, No. 520, Fl. Tas., p. 340.

TRIBE XXV.—GRAPHIDÆ, *Mull. Arg.*, Graph., Fee, pp. 4, 13.

SUB-TRIBE 1.—ENGRAPHIDÆ, *Mull. Arg.*, Graph., Fee, pp. 4, 13.

Genus 51.—Melaspilea, *Nyl.*

1. Melaspilea circumserpens, *Nyl.*, Lich., R. Brown, No. 566.

Genus 52.—Graphis, *Ach.*

1. Graphis intricata, *Fee*, Lich., R. Brown, No. 561.

SUB-TRIBE 2.—GLYPHIDEÆ, *Mull. Arg.*, Graph., Fee, pp. 4, 61.

Genus 53.—Chiodecton, *Ach.*

1. Chiodecton perplexum, *Nyl.*, F. v. M., Vic. Nat., IV., 95.

TRIBE XXVI.—PYRENULÆ, *Mull. Arg.*, Pyr., Cub., p. 375.

SUB-TRIBE 1.—VERRUCAEÆ, *Mull. Arg.*, Pyr., Cub., pp. 376, 398.

Genus 54.—Clathroporina, *Mull. Arg.*

1. Clathroporina eminentior (Nyl.). *Mull. Arg.*, F. v. M., Vic. Nat., IV., 93.

Species, 158.
Varieties, 39.

Note.—The following may be regarded as doubtful:—

1. Cladonia gracilis, *Hffm.*, s. Cluomyce gracilis, *Ach.*, Hook. Jour. Bot., IV., 651.
   „ gracilis, v. ecmocyna, *Ach.*, f. subulata, *Ach.*, Hook. Jour. Bot., IV., 651.
2. Ramalina fastigiata, *Ach.*, Hook. Jour. Bot., IV., 654.
3. Coccocarpia plumbea (Lghtf.), *Nyl.*, s. Parmelia plumbea *Ach.*, Hook. Jour. Bot., IV., 653.

PAPERS AND PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

TASMANIA,

FOR

1893.

(ISSUED JUNE, 1894.)

TASMANIA:
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Contents.

Page
April Meeting I
Welcome to the Acting President I
Election of Messrs. E. D. Peters, M.D., A. Macaulay, M.A., W. Jethro Brown, M.A., LL.D., and W. H. Williams, M.A. ... I
Flora Australiensis II
Glaciation in Tasmania II
Fossil Flora II
Catalogue of Tasmanian Minerals II
Testing Mineral Springs... II
May Meeting IV
Notes on Tasmanian Lichens IV

ERRATA.

On page next 210 description of Plate IV instead "Petraplodon" read "Tetraplodon."

Notes on the Geology of Lake St. Clair and its Neighbourhood ... XVI
Notes on some New and Rare Fish XVI
Centrina salviani... XVI
Centrina bruniensis, Morton XVI
Euremetopos johnstoni XVI
Fourth Vol. A.A.A.S. XVI
Proceedings of the Royal Society of Tasmania for 1892 XVII
The Great Barrier Reef XVII
August Meeting XVIII
Welcome to His Excellency Lord Gormanston XVIII
Address Presented to the President XVIII
The President's Reply XVIII
Apologies for Absence XIX
Proposed Coniferæ Plantations... XIX
Baron Müeller's Notes XIX
Mr. F. Abbott's Notes XIX
Mr. A. Harley's Notes XX

CONTENTS.

Useful Coniferæ for Tasmanian Planting, by Mr. A. O. Green .. xxi
Wolfram and Nickel xxi
Vote of Thanks proposed to the President by the Hon. P. O. Fysh xxii
September Meeting xxiii
Telegram from the President xxiii
Sir R. G. C. Hamilton, K.C.B., LL.D., elected an Honorary Member xxiii
Election of Messrs. Harvey, M.D., and Propsting xxiii
Notes on The Mt. Lyell Mine xxiii
Assay of Three Days Work at Mt. Lyell Mine xxiii
Taxation and Cost of Living in Tasmania xxiii
Coniferæ Planting in Tasmania... xxiv
Celery Top Pine xxiv
October Meeting Lapsed... xxiv
November Meeting xxv
Coniferæ Planting xxv
Norfolk Island xxv
Botanical Notes xxv
Additions to the Museum xxvi

Papers.

Page.

ART. I.—Catalogue of the Minerals known to occur in Tasmania, with Notes on their distribution. By W. F. Petterd ... 1

ART. II.—The Glacier Epoch of Australasia. By R. M. Johnston, F.L.S. (Map) 73

ART. III.—Notes on the Geology of Lake St. Clair and its immediate neighbourhood, together with observations regarding the probable origin of our numerous Tasmanian Lakes and Tarns. By R. M. Johnston, F.L.S. 135

ART. IV.—Discovery of Glaciation in the vicinity of Mt. Tyndall, in Tasmania. (Map.) By T. B. Moore, F.R.G.S. 147

ART. V.—Supplementary Notes: Discovery of Glaciation in Tasmania. By T. B. Moore, F.R.G.S. 149

ART. VI.—Geology of the Lake St. Clair, Tasmania. By Graham Officer, B.Sc. (Map) 150

ART. VII.—Glacial Action in Tasmania. By A. Montgomery, M.A. 159

ART. VIII.—Further Contributions to the Fossil Flora of Tasmania. Part I. By R. M. Johnston, F.L.S. (Plates i. and ii.) ... 170

ART. IX.—Botanical Notes. By Leonard Rodway. (Plates) ... 179

ART. X.—Remarks upon the Disposal of the Sewage of Hobart. By A. Mault 188

ART. XI.—Notes on Mt. Lyell Mine. By E. D. Peters, jun., M.E., M.D. 194

ART. XII.—Additions to the Moss Flora of Tasmania. (Plates.) By W. A. Weymouth 200

ART. XIII.—Description of a new Species of Shark. By Alex. Morton 211

ART. XIV.—Notes on Tasmanian Lichens. By J. Shirley, B.Sc. ... 214

ART. XV.—Testing Mineral Springs. (Abstract.) By Major General Tottenham III

ART. XVI —Australian Mosses. By R. A. Bastow, F.L.S. (Title) IV

ART. XVII.—A Recent Visit to Norfolk Island. By the Bishop of Tasmania. (Abstract) IV

ART. XVIII.—First Settlement at Norfolk Island. By J. B. Walker, F.R.G.S. (Abstract) VIII

ART. XIX.—Notes on some rare fish. By A. Morton. (Abstract) XVI

ART. XX.—Taxation and cost of Living in Tasmania. By R. M. Johnston, F.L.S. (Abstract) XXIII

ROYAL SOCIETY.

APRIL, 1893.

The first monthly meeting of the 1893 session of the Royal Society of Tasmania was held on Monday, April 10. The Acting-President (Sir Lambert Dobson) took the chair. There was a moderate attendance of ladies and members. Mr. E. D. Peters, M.D., M.E.C., was elected a corresponding member, and Messrs. A. MacAulay, M.A., W. Jethro Brown, M.A., LL.D., and W. H. Williams, M.A., were elected Fellows.

WELCOME TO THE ACTING PRESIDENT.

Mr. JAMES BARNARD, a Vice-President, said that before commencing proceedings he thought it was only becoming to acknowledge and welcome the presence of Sir Lambert Dobson in his changed position. On behalf of the Council and Fellows he offered the Administrator hearty congratulations on his assumption of the Presidential chair officially as Governor of the colony for the time being.

Sir LAMBERT DOBSON thanked Mr. Barnard for the very kind way in which he had welcomed him there officially. He was not unknown unofficially within those walls—(hear, hear)—but certainly he had never presided there at a meeting of the Royal Society in the capacity of Administrator of the colony. It was a very great privilege to be there as president for the time being. On the occasion of the opening of the first meeting of a new session he knew it had been usual to deliver a presidential opening address. But Sir Robert Hamilton, previous to his departure, prepared so excellent an address, that almost everything he could say in an inaugural address had been exhausted. Still, there were one or two words he would like to utter. The Royal Society had no doubt done a great deal of good work, and he hoped would do good work in the future. (Hear, hear.) He took it that science was really divided into two parts; metaphysical and physical. The metaphysical drew largely from speculation. In the present century we liked results, and he thought, therefore, that the physical branch was that which really became popular, and likely to monopolise a very large proportion of the attention of the members of the Society. In the metaphysical we knew that we probed a theory, had large speculations, found that they had been speculated on before and abandoned for some other theory, and then came back to the starting point. But in physical science every particle of knowledge gained was pure knowledge. Everything gained by observation or calculation was matter added to the general knowledge of men, and could never be lost. It was in this branch of science that he believed their work really lay. Heretofore, there was no doubt, both with respect to our fauna and flora, we had had a large amount of work to do to discover the peculiarities and principal features of these of our natural products. But naturally that field must become exhausted, and we must look further afield. Here we had one very grand field, which really, he thought, could never be exhausted—the geology of the colony. (Hear, hear.) We had its great history written on the rocks, and as it had taken ages to compile that history, so he believed it would take ages to decipher and read it aright. This line offered a large amount of work for the Society to undertake, and from what he noticed of the papers for that meeting it was one to which attention was being largely directed. The advantage of the little knowledge gained at the Society's meetings might be small, but in all scientific observation it was not individual discovery that was so valuable, but the accumulation of discoveries put together, and individual inferences then to be drawn from those discoveries. In this way science went on increasing at a marvellous speed. Certainly, the march of science during the last century, in the last decade of which we now were, had been something beyond the conception of any individual born at the end of the previous century. And what it would be in the next century Heaven only knew. In this century we had seen steam come up as a motive power; and it had had its use and triumph; and the question now was whether it was not giving way before a power of almost unknown capacity—electricity. We had seen gas rise for lighting; now the question was whether we might not see it almost die out as an illuminant. We had, within the last 25 years, seen the world girdled with the electric telegraph, and what other wonders were now going on could hardly be told. When we came to carry ourselves back to the end of the last century, and the fleet with which Nelson fought at Trafalgar, remembering that one of our modern warships with its few guns could annihilate the whole of that fleet, or that the armies of Napoleon would fall like wheat before the sickle in front of our modern machine weapons, it might well startle us into wondering what the world was coming to. With such an advance of science as many had seen in the present century what might not be expected to be its advance in the future? Every little society like this helped on the advance of science. By careful registration of observations, its members were able to assist to the best of their power the advancement of science in the ensuing century. (Applause.)

CORRESPONDENCE.

A circular letter from Mr. F. M. Bailey, Government Botanist, Queensland, asking for information for a supplementary volume to the "Flora Australiensis," was ordered to stand over, pending inquiries.

Another circular was read from the Royal Society of New South Wales, giving details and conditions under which its medal and £25 are offered for three series of original researches.

GLACIATION IN TASMANIA.

The Secretary (Mr. A. Morton) read an interesting paper contributed by Mr. T. B. Moore, F.R.G.S., Strahan, entitled "Discovery of Glaciation in Tasmania."

Mr. R. M. JOHNSTON, in some complimentary remarks on the paper, observed that its title was rather unfortunate, inasmuch that one of the main facts known for 30 years in connection with the Western highlands was the abundant evidence of glaciation. With that exception he regarded the paper as a very valuable contribution, and thanked the writer accordingly.

Mr. T. STEPHENS concurred in the general tenor of the previous speaker's criticism, and hoped the paper might be regarded as the precursor of several others in what was really a very extensive and important field.

FOSSIL FLORA.

Mr. R. M. JOHNSTON, F.L.S., read some "Further contributions to the fossil flora of Tasmania."

A CATALOGUE OF TASMANIAN MINERALS.

The SECRETARY presented "A catalogue of the minerals known to exist in Tasmania, with Notes on their distribution," by Mr. W. F. Petterd, C.M.Z.S., and read the preface, in which the writer stated that the catalogue was prepared from specimens in his own collection, and whose identification he had verified in the majority of instances by careful analysis.

Mr. JOHNSTON regarded the paper as one of the most important yet given on the subject, and in complimenting the writer, said the Royal Society and everyone else interested in minerals should feel indebted to Mr. Petterd for devoting so much time in affording valuable information on such an important subject.

TESTING MINERAL SPRINGS.

Major-General TOTTENHAM made some remarks on "The rough testing of mineral springs," in which he said that in a country so rich in minerals as Tasmania there must be mineral springs, wells, and creeks in unusual numbers. He suggested that yachtsmen and explorers might well invest a few shillings in a tiny case of tests, systematic search, collection of information, and chemical investigation of their medicinal and other commercial values. This was extremely desirable in furtherance of the Premier's idea of placing Tasmania more prominently before the world.

The general business having been transacted, the usual vote of thanks to writers of papers terminated the meeting.

MAY, 1893.

There was a large attendance of ladies and gentlemen at the monthly meeting of the Royal Society held on Tuesday, May 13, at the Museum. Sir Lambert Dobson presided.

TASMANIAN LICHENS AND AUSTRALIAN MOSSES.

The SECRETARY (Mr. A. Morton) asked that, with the exception of the first paragrah in "Notes on Tasmanian Lichens," by Mr. John Shirley, B.Sc., Inspector of Schools, Queensland, the two papers left over from the previous meeting might be taken as read. The other paper was one on "Australian Mosses," by Mr. R. A. Bastow, F.L.S., Melbourne. Both writers are corresponding members of the Tasmanian Royal Society.

A RECENT VISIT TO NORFOLK ISLAND.

The BISHOP OF TASMANIA read an interesting paper entitled "Notes on a Recent Visit to Norfolk Island." He stated that his visit in August, 1892, was but a hurried one, and his engagements were numerous, but I seized every opportunity that presented itself to me to discover all I could of the characteristics of this little spot so unique in its history from many points of view. My chief informant was Dr. P. H. Metcalfe, the medical officer of the island, indefatigable alike in the discharge of his professional duties and in the promotion of many branches of science. The first view obtained from the deck of a vessel reveals a larger island with two satellites. The largest of the latter is Phillip Island, a precipitous mass of red basalt set in the bluest of seas, and forming a striking feature in the landscape. Close to the shore of Norfolk Island is the little Nepean Island. The basalt of Phillip Island is remarkable for the brilliance of its colouring. A close examination shows that the rock, where disintegrated, has taken numberless delicate and vivid hues. As my informant defined it, "it is like mottled soap." There was a time when Phillip Island was covered in many places with grass and herbage, and the pines were numerous. Sad havoc has been caused amongst the vegetation by the introduction of rabbits. These little pests ate up every green thing, the grass died, and then the heavy rains washed the soil away. The rabbits themselves are now perishing, but a few are still to be found—thin and diminutive, the mere wrecks of their species. Dr. Metcalfe states that it is a source of wonder to him how the pines that are still standing exist at all. Their roots are exposed to the air, and seem to have scarcely any foot-hold on the bare and stony ground. He states also a remarkable fact—that here the mutton birds lay their eggs under the roots of the trees, and under boulders, as there is no soil. To those who know the ordinary habits of the mutton bird this is a surprising fact, and argues at least an extreme affection on the part of these petrels for this island, since it has induced them to change their modes to suit the circumstances. Nepean Island is merely a mass of low, flat rock. There are, I think, two pines still standing on it, and doubtless these will soon perish. This spot is a rich hunting ground for the collector of eggs. I come now to the main subject of my paper. From the sea the view discloses cliffs of about 100ft. high, broken here and there by gullies which form rocky bays, where, however, boats could only land in very calm weather, and from the landing stage there would most likely be no path upward except for a goat or a Melanesian, who seems as sure-footed and as free from fear as the aforenamed quadruped. Above the cliffs there are visible masses of pines, interspersed with stretches of grass, so green and thick that it recalled memories of an English landscape. Whether you land at the old township or at the Cascades you are at once amongst these grassey valleys, dotted here and there with pines, forming an enchanting prospect. Guavas grow wild in the gullies, bananas—a sort of wild

Solomon—arum lilies, and lemons in countless thousands meet the gaze of the delighted tourist. The lemons and guavas are the property of any who choose to pick them, and the former trees are covered with fruit at all times of the year. Seen at such a season as that during which I visited this spot, it is impossible to deny it the title of a little earthly Paradise. The pine indigenous here should be seen on its native soil in order to be appreciated. Specimens 200ft. high, and of great girth, are not infrequent. One of these still existing measures 35ft. 4ft. from the ground. A grand avenue of these pines, planted by the convicts, extends for a mile and a-half in a straight line, and leads from the old township, with its long cleared valley and watermill, to the property of the Melanesian Mission. Specimens of the rocks of this island have been forwarded to Mr. Stephens for his inspection, and that he may favour the Society with his views upon them. Dr. Metcalfe informs us that there are scarcely any wild flowers. Great injury is being done to the original vegetation by the introduction of sheep and cattle, which are allowed to roam at will over great portions of the island. Even the young pines are unable to grow, though the grass everywhere is covered with little sprouts an inch or two in height. Palms and tree ferns are sharing a like fate. No young plants now grow to maturity. Dr. Metcalfe has chiefly turned his attention to the birds of the island and to ferns. He has given me a list of 10 species of sea birds which regularly visit this group, 16 land birds, and a further list of 13 species, some land and some sea birds, which are visitors and do not breed here. In the name of the Royal Society I ventured to make a request that he would present to the Museum specimens of the eggs which he had collected, and the request was at once granted. I beg to present them in Dr. Metcalfe's name to the Hobart Museum. (Applause.) In addition to the birds mentioned in the lists which I subjoin, the Rev. J. Palmer, of the Melanesion Mission, has introduced the pheasant, Virginian quail, and rock pigeon. These are all increasing in numbers, and do no injury to the island in any way. I think I am right in saying that there were no quadrupeds indigenous to the island. Those which exist at the present time have been imported. There has been a steady deterioration in the breed of cattle and sheep during the last 10 years. I fear that little trouble is taken by the Norfolk Islanders in matters such as these which require foresight. The present by Lord Carrington of two good bulls has aided in restoring to some degree the breed of cattle during the last three years, but the horses are poor looking objects, and perhaps, as regards the sheep, it will sufficiently describe their present condition if I state that a common weight for a sheep in Norfolk Island is from 18lb. to 20lb. The remedy for this is, of course, the exercise of energy in importing fresh blood, and in the formation and fencing of proper paddocks of good grass. At present there is no method in the feeding of stock, and the land cannot carry the number of poorly-bred animals which wander everywhere, destroying much that is of interest to the scientific observer. As is well known, the community at Pitcairn Island were removed to Norfolk Island in 1856. Their representatives at the present day claim that the whole island was made over to them to the exclusion of all others, and that permission must be received from them before any new-comer has a right to settle. I am not competent to decide what can best be proved by documentary evidence. But the question affects the condition of the old convict buildings. They are rapidly going to ruin. The central prison—the Octagon—is roofless, the partition walls of the cells are crumbling away, but the outer wall is, upon the whole, still in good preservation. The whole mass of the various structures is grouped in what is rather flat land, and bare of trees; the situation is not nearly so beautiful as that of the analogous Port Arthur. There is no esplanade at the water's-edge—nothing but a stone pier of no great dimensions. But for this there is a good reason, in the absence of any harbour. The landing had as often as not to be effected at the Cascades, upon the other side of the island. The

Governor's house stands well upon an eminence commanding the whole extent of the penal establishment (14a). There is one point, however, from which the Norfolk Island establishment cannot compare with Port Arthur. There was no picturesque church such as we are acquainted with in Tasman Peninsula. By the courtesy of the present chaplain who resides in Government House, I was permitted to inspect the rooms. He showed me that the structure was deliberately planned, so that in case of an attack made by convicts upon the premises, a sturdy defence could be made at seven distinct points within the building, and if the besieged were beaten off from every one of these one after the other, the last rallying point was so arranged that an exit could be effected through the cellar into the open air. Two distinct nationalities, it may be said, inhabit Norfolk Island at the present time: the Norfolk Islanders, or ex-Pitcairners, and the Melanesian mission. Anyone who knows anything of half-caste races can easily draw up a fairly correct list of virtues and vices inherent in a race of such mixed blood as this, and it is not incumbent upon me to attempt the task here. It is sufficient to say that it would be difficult to find anywhere a more pleasant, laughter-loving, hospitable people than the Norfolk Islanders of this day. There can be no doubt, however, and I think the thoughtful among them realise it, that the effect of constant intermarriage within so small a community has had a serious effect already in deterioration of the race, physically and mentally. It is a matter which calls for immediate attention in a sympathetic and liberal minded spirit. The community is ruled by a Governor, who is also Governor of New South Wales. The Governor has a seal, appoints judges, and can sell or allocate waste lands. The laws are framed as far as possible on the model of those which were in force in Pitcairn Island. The actual government is in the hands of a Chief Magistrate and two councillors, elected annually. The Chief Magistrate must be a landed proprietor, and over 28 years of age. The councillors must be, at least, 25. The annual election is on December 26. The chaplain presides, and the proceedings open with prayer. All can vote who have resided six months on the island, are 20 years of age, and can read and write. The chaplain has a casting vote, but he cannot be either magistrate or councillor. The officers can summon to their aid in case of necessity any one in the island on penalty of a fine for non-attendance. The Chief Magistrate is expressly ordered to attempt to settle all quarrels out of court. If this is impossible he may fine up to 50s. without appeal. The highest fine he can inflict is £10. If the parties are unwilling to abide by his decision a jury of seven is empanelled, and their decision is final. Offences of a more serious nature are sent for trial to Sydney. It is interesting to note that the jury is entitled to payment, and that one hour is computed at one-eighth of a day's work. As a rule fines are worked out in labour on the roads or elsewhere. A list of all males over 25 is kept, and these are called elders. When a jury is needed the names are put into a bag, and the first seven drawn out compose the jury for the occasion. The rules regarding education are strict. The children must attend school from the age of 6 to 14. If any child is absent for more than two days on account of sickness the chaplain must certify the fact. The fine for non-attendance at school is 6d. per day. Each child pays a school fee of 10s. per annum. This and the fines for non-attendance go to the schoolmaster. (From which it would appear that if only the master could induce all his charges to absent themselves, his post would be a distinctly lucrative one). The school is under the care of the chaplain. No intoxicating liquors are permitted, not even (there is a touch of irony in this), not even to the chaplain. This rule in its breadth is, I believe, rigidly enforced. There is a fine for using profane language varying from 5s. to 40s. No furious riding or driving is permitted on the roads. No person may sell land to any one who has not obtained the consent of the Governor previously. All are aware that the coloured element in the Norfolk Islander is derived from Tahiti.

The population now consists of 650 on Norfolk Island, and there are 125 more who are still at Pitcairn Island, they or their parents having returned of their own accord to their old home. At the present time there are some 20 (not more) who may be called pure half-castes. Of this number is, of course, the aged Mrs. Hobbs, who still lives, the wife of the well-known clergyman. His Lordship made some remarks on the language of the islanders, and recorded the derivations of some extraordinary words, with a number of highly amusing illustrations. He continued: "The other community living on this island is, as is well known, the Melanesian Mission. In 1858 permission to settle on Norfolk Island was refused, at the earnest request of the Norfolk Islanders themselves, by Sir W. Denison, then Governor of New South Wales, on the score that the morals of the Pitcairners could be corrupted by being brought into contact with savage Melanesians. In 1866 Bishop Patteson was more fortunate than the first Bishop Selwyn had been, and 1,000 acres were bought at a cost of £3,000, the money being funded for the benefit of the Pitcairners. Since then the Mission School has grown, until a large sum of money has been invested in buildings. The school usually numbers about 170; these are scattered in houses under the charge of the clergy, the houses being embowered among trees and gardens, whilst the sound of the chapel bell, and the meeting in the hall for meals, recalls a true type of college life. To a keen observer perhaps the most remarkable sight at the chapel services, twice daily, is the Melanesian with frizzled pate and bare feet who plays the organ, making full use of the pedals, and reproducing the music of all our great composers. A relay of organists is kept up, and one of the bitterest of regrets to these musicians on leaving Norfolk Island as teachers to their own people is their severance from musical instruments. No harmonium has yet been made which can resist the damp and the insect pest of these tropical islands. Of the farm of 1,000 acres, some 200 are cultivated, the rest being used for pasture. It is calculated that two-thirds of the food needed by the mission people is raised on the farm. Of course far more could be obtained were skilled farmers employed. But as it is part of the system that the scholars should learn the best methods of farming which are appropriate for their future homes, the farm work is done by the clergy and their scholars entirely, working side by side, the only external assistance being that of a bailiff. The Mission also takes its share of the roads of the island, and one is somewhat proud of the order in which their part is kept. It is difficult to see how the Norfolk Islanders could dispose of their produce were it not for the Mission people, who are their best—I was almost about to add their only—customers. The sale of produce to the Mission, and the proceeds of whaling, are the chief sources of profit to these people. As whalers they have long had a high reputation, and are noted as bold and excellent boatmen. It is a great pity that the difficulty of transport should prevent a trade in oranges. The Norfolk Island orange seems to me to surpass in flavour any I have ever eaten. Indeed, the day may come when in this mild and equable climate many fruits may be grown to perfection, which are now neglected here. What is needed is more energy and greater foresight among the present inhabitants. But I feel unwilling to conclude this paper with any adverse criticism of these people, however mildly put. There is a feeling abroad among them that all who live on their island come for the purpose of giving good advice. As one who was more than kindly received—welcomed indeed with open arms—I trust a happy and useful career is in prospect for a community which has a history both romantic and unique. Transported now to a region which cannot be surpassed for quiet beauty, their lot should be as happy as it is highly favoured by nature." (Applause.)

Appended to the paper were lists of birds breeding upon the island and some adjacent rocks, and a list of ferns on Norfolk Island, furnished by Dr. Metcalfe. The paper was illustrated by lantern views by Mr. Nat Oldham. Pictures of the township, the pier, the famous avenue of pines, Government House, etc., were thrown on the screen, and served to elucidate the observations on the topography of the island. Many of these scenes were from photographs by the Rev. C. Bice, of the Melanesian Mission, who also pointed out various spots of interest.

THE FIRST SETTLEMENT AT NORFOLK ISLAND.

Mr. J. B. WALKER, F.R.G.S., read a paper under this title, dealing very interestingly with the story of the solitary islet set in the summer sea, so curiously interwoven with the history of our own colony, which was for a quarter of a century a dependency of Tasmania—and thus the penal settlement—until in times within the memory of many present it was abandoned, chiefly through the philanthropic exertions of Bishop Willson. A fact not so generally known, however, he mentioned was that immediately after the planting of our colony, only a year or two after Governor Collins founded Hobart, the Norfolk Island settlers were deported in a body to Tasmania, at which time half the population of this colony, and nearly all its free settlers were Norfolk Islanders. He sketched the discovery of the island by Cook, October 10, 1774, the administration of Philip Gidley King, the first commandant, and the early struggles of the settlement, leaving its gradual decline, and the final deportation of its settlers to Tasmania, to be dealt with at a future time.

Mr. C. T. BELSTEAD, a resident of Norfolk Island for many years, and whose information related chiefly to the period intermediate between that dealt with by the two papers, questioned the erection of Government House as a sort of fortress, and could not see why any difficulty should be experienced in getting geological specimens from Phillip Island, seeing that he had been there on a camping expedition. He regarded Bishop Montgomery's paper as interesting and valuable.

Mr. F. BELSTEAD strongly deprecated the exaggeration of novelists in their description of past events on Norfolk Island, and said that having lived there during a portion of the period covered by Marcus Clarke's "For the Term of His Natural Life," he could testify that many of the writer's statements were largely overdrawn.

Sir LAMBERT DOBSON proposed a vote of thanks to those who had contributed to the evening's discussion by papers and information. Regarding the charge of exaggeration, he thought there were horrors to be raked up in the history of the British Navy that would surpass in inhumanity those recorded at Norfolk Island, but it were better that the curtain of oblivion should be drawn over such matters.

The vote of thanks was unanimously accorded, after which Mr. E. P. Jones gave a phonographic entertainment with Edison's latest machine, which was very instructive and highly appreciated.

Mr. A. Mault's paper on "The Disposal of the Sewage of Hobart" was postponed till the next meeting.

JUNE, 1893.

The monthly meeting of the Royal Society of Tasmania was held at the Museum on Tuesday, June 13, Mr. J. Barnard (senior vice-president) occupying the chair. There was a moderate attendance of members and several ladies.

ADMISSIONS.

The following gentlemen were balloted for and elected Fellows of the Society:—Messrs. T. E. Stewart Abbott, M.R.C.S., L.S.A., W. T. Strutt, F. W. Piesse, Colonel Cox, C.B., and Mrs. C. Eddie (Launceston).

SOME ADDITIONS TO THE MOSS FLORA OF TASMANIA.

Mr. W. A. Weymouth read a paper dealing with Tasmanian mosses (1) new to science; (2) known species now first recorded for Tasmania; and (3) a few already recorded for this colony, but either rare or not previously described. He said:—The determinations are by European specialists. One of these, Dr. O. Burchard, of Hamburg, has reported 65 new species, a list of which was received from him by the Secretary of this Society in January, 1892. None of these determinations having up to date been supported by descriptions for publication, I have hitherto refrained from calling your attention to them; and only a few that have been revised and confirmed by another authority are included in this paper. Professor V. F. Brotherus, of Helsingfors, who has for some years been engaged upon the mosses of Australia, and more recently upon those of Tasmania also, has just published in Part II. of "Some new species of Australian Mosses, described by V. F. Brotherus," original descriptions of six new species from this colony. My versions of these descriptions are given below. Following them are other new species, for which descriptions will be forthcoming later on. One of the most interesting of our mosses is *Pleurophascum grandiglobum* (Lindberg), which up to the present has been recorded only as collected by Mr. R. M. Johnston near the Picton River. I can now add that in January, 1892, Mr. L. Rodway handed me a fine specimen obtained by Mr. Wm. Fitzgerald in the neighbourhood of Mount Zeehan. In December of the same year Professor Brotherus sent me one collected by Mr. T. B. Moore on the highlands of Mount Tyndall (from Mr. R. A. Bastow I have since also received a bit of this); and in May of the present year the Rev. John Bufton sent me some obtained by himself at Port Davey. I would call the attention of the Fellows present to the mounted examples on the table; and would especially mention that Mr. L. Rodway, to whom I am indebted for ever ready help with microscope and pencil, has kindly undertaken to illustrate some species by drawings of their several parts. (Here followed names, descriptions, and other particulars.)

Mr. Rodway said that some of the specimens he had examined for Mr. Weymouth were very rare, of unusual interest, and not found in any other part of the world. He had made sketches of some for him, and suggested that these should be reproduced in the Society's transactions if possible. (Hear, hear.) Where bryologists could not obtain specimens, light correct sketches would greatly enhance the value of the journal. (Hear, hear.)

DISCOVERY OF GLACIATION IN TASMANIA.

Mr. T. B. Moore, F.R.G.S., contributed some supplementary notes to his paper, read at the April meeting on "The discovery of glaciation in Tasmania.

GLACIAL ACTION IN TASMANIA.

This was the subject of an interesting paper by Mr. A. Montgomery, M.A., in continuation of the discussion on Mr. Moore's paper on "The discovery of glaciation in Tasmania." Mr. Montgomery stated that having himself come upon evidences of ice action in February last in the neighbourhood of Mount Pelion, and being at that time ignorant of Mr. Moore's discovery four months earlier, he had intended in any case to submit a few observations on the subject of glaciation. Before passing on to what he personally saw, Mr. Montgomery made some remarks on Mr. Moore's paper. He said it was by no means a new discovery, as Mr. Moore appeared to think, that there were glaciers among our western highlands, for Mr. R. M. Johnston, and, if he was not mistaken, the late Mr. Sprent also, noticed the existence of large erratic blocks in the valley of the Mackintosh River, and inferred from these that they must have been brought down by ice. Messrs. Dunn and Moore's and his own later finding of striated boulders, smoothed surfaces, *roches-moutonnées*, and moraine drifts, only confirmed the correctness of the views of these earlier observers. Mr. Moore was, therefore, in error in ascribing to Mr. Dunn the honour of being the discoverer of evidences of glacial action in Tasmania, though perhaps he was the first to bring forward indisputable proof. The country described by Mr. Moore round Mounts Sedgwick and Tyndall and Lake Dora was very similar to that round Mount Pelion. The conglomerates he spoke of as Devonian were of much interest, and the further examination and fossil evidence of their age would no doubt add an important chapter to our knowledge of the geology of the colony. In his journey from Barn Bluff to Zeehan, Mr. Montgomery said he noticed conglomerates of three distinct ages. To Mounts Sedgwick and Dundas, mentioned by Mr. Moore as capped with diabase greenstone, might be added Barn Bluff, Mounts Pelion, Ossa, East Pelion, the DuCane, Eldon, and Oakley Ranges, as all showing the same feature. While not saying that ice was the only considerable agent in cutting out the valleys, the shape of many of them, and the contour of the hillsides suggested that the present configuration of the surface was largely due to glacial erosion. The first place Mr. Montgomery came upon plain proof of ice action was near East Mount Pelion, between a branch of the River Forth flowing from that mountain and from Lake Eyre, and another small feeder running in a deep gully at the foot of the Oakley Range. The high narrow plateau lying between Mount Pelion and Barn Bluff also showed in its every contour the former presence of glaciers. On the slopes of Barn Bluff there were two more lines of moraine ridges separating flat valleys which had been the beds of adjacent glaciers. Going from Barn Bluff towards Granite Tor, the rolling hummocks and rounded ridges continued to be met with on the high lands, and descending suddenly and abruptly from these were huge deep ravines and valleys. The lakes at the head of the west branch of the Murchison River, and on the divide between it and the Henty, Lakes Spicer, Dora, Beatrice, Rolleston, Julia, Selina, also probably indicated the former presence of glaciers, and he thought they must come to the conclusion that the whole of the deep gorges among the western mountains, now occupied by the head-waters of the Pieman, Henty, and King Rivers, had at no very distant period of time been occupied by rivers of ice. He admitted the want of evidence to prove widespread glaciation in the eastern parts of the colony, and mentioned the matter rather because it seemed an almost necessary consequence of admitting the prevalence of ice in the western highlands that it should also have existed in the east, than on account of any direct proof. At the head of the King River, on the western slope of Mount Reid, there had been discovered a deep lead presenting suggestive features of ice action. In glancing at the causes of glaciation, he said it might be due to the greater elevation of the land and geographical changes, resulting in a redistribution of sea and land, diversion of ocean currents, and so on, or it might be due to astronomical causes as so lucidly explained by Sir Robert Ball in his recently published little book on "The cause of an ice age." It was probable that the refrigeration of the climate of Tasmania, which led to the gathering of glaciers on its high mountains, was due to the causes insisted on by Dr. Croll and Sir Robert Ball. While inclined to believe that the ice-covering was more extensive than Mr. R. M. Johnston was disposed to allow, he agreed with him in the main, and did not think that the whole country could have been ice-bound. Many of our indigenous animals existed in the colony before the probable date of the glaciation, and if the latter had been extreme would have been killed out altogether; in which case, if he was right in referring the cold period to a time subsequent to the severance of Tasmania from the Australian continent, there would have been no chance of a fresh stock having been obtained from the mainland after the climate again became milder. Outside this colony evidences of glacial action had been found in the Australian Alps and on the beach near Adelaide. A quotation from the Challenger reports showed that Kerguelen Land had been at no very ancient date completely covered by heavy ice. Mr. Jack, in referring to this, points out that if the Antarctic ice cap were extended to cover Kerguelen Land, there would be no improbability of its also reaching the shores of Australia. The whole subject, said Mr. Montgomery in conclusion, was most interesting, and had numerous aspects on which more light was required, and fresh proof of the extent and date of the glacial action all over the Southern Hemisphere would be eagerly looked forward to.

THE GLACIER EPOCH OF AUSTRALASIA.

Mr. R. M. JOHNSTON, F.L.S., read an elaborate "Review of the evidences of former glaciation in Australasia, with critical observations upon the principal causal hypotheses which have been advanced to account for glacial epochs generally." In introducing the subject, he said:—The study of the geology of the globe we live in presents many fascinating subjects. In its *cosmical* aspect we may confine ourselves to speculations as to its mode of origin from nebular matter to the final stages which culminated in its specific differentiation as a subordinate among many other members of the solar system. In its *geognosy* we may revel in the nature and complexity of the combinations of the elements which constitute its varied rocky materials. In its *geotectonic* or *structural* aspect we may enter upon questions relating to the nature of and the manner in which the architecture of the earth's crust has been developed, modified, or transformed. In its *dynamical* aspects we may inquire into the complex causal forces which are, or have been, engaged in producing disturbances, movements, and changes in its physical structure. In its *stratigraphical* aspect we may devote our attention in tracing the chronological sequence and relationship of the various formations which comprise its visible crust or shell. In its *physiographical* aspect we may dwell upon its surface feature of mountain, valley, plain, plateau, lake, canon, river bed, or ocean abyss, and try to understand the causes which have operated in producing its sculptured form, and, finally, in its *palæontological* aspect, we may trace the history of the organic life forms whose remains are found preserved in the rocks, their succession or evolution, and their relationship to the corresponding succession of rocks. The geological field is thus wide and varied, and we may become so absorbed in the investigation of any one division of the several aspects referred to as to forget the claims and importance of the others. It is well, therefore, from time to time, that we should have our attention aroused to the claims and interests of branches of geological study outside of that to which each of us respectively may happen to be too deeply immersed. We, therefore, cannot realise the benefit of such papers as those of Messrs. T. B. Moore and A. Montgomery, M.A., which arouse us from our own favourite grooves, and recall our attention, for a time at least, to that large and important phase of dynamical geology known as glacial action. This phase also at once inevitably leads on to consideration as to its cause or cosmical aspect; to its effects as in its stratigraphical and physiographical aspects, and to the period of its manifestation as in its chronological aspect. Before we enter upon the question of evidence as to the occurrence of a former climate in Australasia sufficiently intense to be designated "A Glacial Epoch," we must briefly consider the character of the evidence by which we infer its actual occurrence. It is obvious that we cannot directly approach the subject of the earth's temperature at a former period, for the original cooled air and the frozen water cannot be conceived to be stored up and preserved for our observation, as in the case of ancient forms of life preserved in the rocks. But while directly we can gain no information as to temperature, we have abundant evidence preserved of the effects, which, according to our present knowledge, can only have been produced by an intensely low temperature acting upon watery vapours while subjected to the universal law of gravitation. It is therefore clear that it is in the preserved dynamic effects of moving masses of snow or ice and negatively in the poverty or total absence of life forms that we have the best, if not the only, means of inferring the severity of the climate of a former period. After a lengthy and detailed illustration of the subject in all its aspects and bearings, assisted by a specially executed diagram, Mr. Johnston concluded by observing that it was sufficient in "respect to evidences bearing upon causes of glaciation, in Australia and Tasmania at least, to justify me in adopting for the present the following conclusions:—1. That the Glacier Epoch of Australasia was probably comparatively mild in its effects, manifesting itself mainly by increased rainfall in lowlands, and by establishing local glaciers in the alpine regions of Southern Australia and Tasmania, and in greatly extending the spread of the existing snowfields and glaciers of the New Zealand Alps. 2. That probably, in Australia, the local glaciers of the Alps melted before reaching the 2,000ft. levels within the valleys which descended continuously from the elevated snowfields; and in Tasmania it is most probable that only on the western slopes of our western highlands was there sufficient precipitation to yield glaciers, any of which did not reach the sea, and probably were melted within their own valleys before reaching the 1,000ft. level. 3. That the date at least of our most refrigerated period was probably isochronous, and mainly caused by the maximum cycle of eccentricity of the earth's orbit with winter in aphelion, probably near to the beginning of our Neogene Period, say 850,000 years ago. 4. That if the latter be true, it proves that the astronomical theory by itself (*i.e.*, without concurrence of geographical conditions) would not adequately account for the ice age of Europe and North America, nor for the absence of marked glacial phenomena among the earlier tertiary deposits of Europe, at points of time concurring with the earlier cycles of eccentricity of the earth's orbit with winter in aphelion. I do not expect that my conclusions will be accepted at present by many geologists who have already attained to crystallised views on the matter, but even these may be prepared to allow that, granting the premises assumed by me, my conclusions follow as a logical necessity."

Messrs. T. STEPHENS and O. H. GREENE having made some observations on the papers read and the subjects dealt with, the usual votes of thanks to the contributors were passed, and the meeting concluded.

JULY, 1893.

The monthly meeting of the Royal Society was held at the Museum on July 11. Sir Lambert Dobson presided, and there was a fair attendance of Fellows, together with a number of ladies. Mr. G. E. Spencer was elected a Fellow.

CORRESPONDENCE.

A communication was received from Mr. James Barnard, Vice-president, offering for the Society's acceptance a likeness of the late Captain Montague, a former Colonial Secretary prior to the introduction of responsible government, who was eminent as a statesman and high-minded English gentleman, and who was instrumental in advancing the prosperity of the colony during his official career. Mr. Barnard said he believed the portrait to be unique, not having heard of a similar copy being in the possession of any resident in the island.

The letter and portrait were laid on the table amid applause.

PROPOSED INTRODUCTION OF SOFT WOOD TREES.

A letter from Mr. A. Harley to the Secretary was read, in which the writer asked for an opinion concerning the introduction into the colony of soft wood trees, such as the Baltic Pine, Oregon Pine (North America), and Kauri Pine (New Zealand), but especially the Baltic Pine, according to the latitudes of the countries where they grow nearly corresponding with ours, they should thrive well here. "The idea originated from noticing a tree (a species of fir) growing in the grounds adjoining St. George's Church, and near the entrance to the Sunday-school. It is over 9ft. in circumference, and has not been there quite 30 years, so that I consider if it had been attended to when young with the object of producing timber (by topping off the branches), instead of for ornament, it would have been much longer and thicker at the butt. Baltic pines are imported into Tasmania in the shape of deals, apple cases, and spars for vessels; a spar from 4in. to 6in. in diameter sells at about 1s. per running foot, and larger ones at increasing prices, and often they are not obtainable at any price, although preferable to other woods on account of its lightness. In England the spars are cut into lengths, and used for the supports for the roofs of coal mines. They might be grown here, and introduced into such places as Broken Hill for the same purpose, as our colonial timber is not used there on account of its weight, and consequent heavy freight on the railways, Oregon pine being preferred. I believe the Baltic pine would be fit for small spars a few years after planting out. Some seeds of the trees mentioned might be introduced, and a trial on a small scale made perhaps in a few private gardens, where they could be tended, to see whether it would be advisable to cultivate on a larger scale."

Hon. C. H. GRANT, M.L.C., said he thought the prices stated rather exaggerated. Baltic spars had arrived here, and were difficult to dispose of. He had known them almost given away, and did not think, with the writer, that there was a great demand for them. The spars greatly used by our builders were cut out of the bush. The growth of Baltic timber here would not be remunerative for that purpose, nor for timber. It would be a long time before forest trees would be advanced sufficiently for building purposes, therefore there was not much encouragement for anyone to start on their own account. It might be well for the Government to try them as an experiment on the waste lands for the benefit of futurity. A better timber to plant would be the larch, which was more valuable in every respect, being useful for sleepers and other purposes, for which Baltic timber was far inferior.

Mr. R. M. **Johnston** said he had been giving attention of late to the question of the importation of soft woods into this colony. Soft wood was so easily workable for some purposes, that no matter how excellent our own woods were, and we had some, particularly stringy bark, which was very good—yet some soft woods, such as the kauri pine of New Zealand and Baltic timber, were imported here to a large extent. It had occurred to him that there was a very large amount of waste lands in our upper plateaux that if experimented on would be found suitable for the growth of such timbers as we now obtained from Europe. These lands would be of no use for any other purpose. He would like to hear the opinions of Baron Von Müeller and Mr. Abbott as regarded the proper species likely to succeed in these upland situations, and moved that both be communicated with on the subject. It occurred to him that such a planting would in the course of 15, 20, or 30 years be of great advantage to the colony. (Hear, hear.)

Hon. N. J. **Brown**, M.H.A., supported the motion, and said he would especially like the matter referred to Mr. Abbott, because from time to time trees were supplied for planting in various country places, and he noticed that the *Pinus insignis* was largely used for this purpose. But *Pinus insignis* was utterly useless as a timber tree, and if Baltic and other useful timber could be grown here it would be far better for Mr. Abbott to have a supply for distribution. (Hear, hear.)

Mr. E. D. **Swan** questioned whether the expense of planting the trees and carting the timber would not be against their introduction, and whether the cost would not be more than that of getting the timber from its native country.

Mr. A. O. **Green** said the question attracted a good deal of attention 40 or 50 years ago in England, where there were large tracts of healthy land with a hard pan underneath. This land was useless, but it was found to be reclaimable by the planting of fir trees, which in 30 years became remunerative. In 15 years they were thinned out and the spars sold. The timber we got here was cut from trees not more than 1ft. in diameter. Trees would grow to that extent in this climate within 15 or 20 years, and would probably be planted by many people round their homesteads and become very remunerative. The timber obtainable here was very good, but the soft timber, if good, was expensive, and the want of good soft timber was felt by every builder in the colony. Timber native to this colony would not, with few exceptions—keep its form when planed. This was a disadvantage against our hardwoods. Something might be done here as was done with the waste lands in Denmark, where very large wastes had been brought under cultivation for the growth of fir trees, and this had also been done in England. Waste lands that would not keep a sheep, scarcely a kangaroo, might be utilised for these purposes. (Applause.)

Sir **Lambert Dobson** said we had one very good soft wood in this colony—Huon pine. But that was very rapidly dying out, and soon there would be none in the country. There was no doubt that if the button-grass plains could be made to grow Baltic timber, or anything else it would be turning into the useful what was now useless. At any-rate, if the experiment were made it would be a step towards the solving of the question, and it might bring out, in one way or another, the way how the proposal might be carried out hereafter. (Hear, hear.)

The motion was carried unanimously.

THE GEOLOGY OF THE LAKE ST. CLAIR DISTRICT.

Mr. **Graham Officer**, B.Sc., Melbourne University, contributed a paper on "The Geology of the Lake St. Clair District, Tasmania."

It was an attempt to give some account of the main geological features of the district, from observations made during a recent visit to the lake by a party, including Professor Spencer, of Melbourne University, the writer, and several others. The inclement weather prevented extensive observations; therefore the present account purported to be nothing more than a geological sketch. Lake St. Clair is situated on the great central greenstone plateau of Tasmania, near the western boundary of the plateau, and a little to the north of the central part, its northern shore being cut by the parallel 42deg. S lat. The elevation of the Queen of Tasmania lakes is about 2,400ft. above sea level, and it lies in a long, deep, narrow valley, bounded on the east by the Traveller Range, and its off-shoots Mount Ida and the Rugged Mountains between it and the Ducane Range; and on the west by Mounts Olympus, Byron, and Manfred. The lake is 11 miles long, and its greatest breadth about two miles, with a recorded depth of water of 590ft. At the north end the valley extends to the foot of the Ducane Ranges, some 10 miles beyond this extremity of the lake. The southern shore shelves up to a succession of low greenstone ledges and button-grass flats. The shores of the lake are remarkably regular, and at the southern end occur the only indents of importance—Cynthia Bay on the west and the Lake Basin on the east. The latter is almost land-locked. From it the Derwent starts on its way to the south. The lake is fed by numerous streams and torrents, the principal ones being the Narcissus (Hamilton), on the north, flowing from the Ducane Mountains; on the east a stream from Lake Laura, and another from the mountains behind Mount Ida; while Cynthia Bay receives the Cuvier. The latter river rises from Lake Petrarch, a small sheet of water just under Olympus on the opposite side from Lake St. Clair, and about 560ft. above it. The Cuvier flows down a broad, undulating valley, known as the Vale of Cuvier. This valley runs in a S.E. and N.W. direction, and is bounded on one side by the Olympus Range, and on the other by Mount Hagley. The most important point at present in the geology of this district is the relation of the greenstone to the carboniferous rocks. It may be said that Mount Olympus affords the key to the geology of the district. There seems to be no reason to doubt that the sedimentary beds extend right along to the N.W. extremity of the mountain, occupying the same position relative to the greenstone at this side that they do on the other. This is indicated by the numerous and often very large blocks of sandstone and conglomerate that occur mingled with masses of greenstone towards the upper end of the Cuvier Valley. The summit of Mount Olympus is much like that of Mount Wellington. A noticeable feature was the presence of several large fissures, but as to their origin he did not care to speak definitely. Perhaps they were due to dislocations, perhaps to the undermining action of water in wearing away the underlying rock. The appearances seemed to him to point clearly to the greenstone being of later date than in the sandstone. No sign was seen of the elder palæozoic rocks represented in Mr. Johnston's map as occurring in the Cuvier Valley. The origin of the lakes of the great central plateau, continued the writer in summing up, is a question which affords ample scope to any geologist who will undertake their investigation. Lake St. Clair was first supposed to be a crater lake, but of this there is no evidence. As Tasmania is undergoing a movement of upheaval the rivers must, geologically speaking, be rapidly lowering their channels. The course of the Derwent affords ample evidence of this. And thus the level of the Lake St. Clair waters must be gradually being reduced. From the top of Mount Olympus we counted about 30 lakes and tarns on the opposite plateau, occupying undoubted rock basins in the greenstone. We did not find the slightest trace of glaciation. I am much inclined to the opinion that most of the basins of the Traveller Plateau lakes will be found to be satisfactorily explained by the ordinary process of subaerial weathering and denudation. We found no fossils *in situ* in the sandstone of this region, but on the beach about the boathouse pieces of silicified wood are not uncommon. Colonel Legge gives a very clear and accurate description of this region, and his paper was of much assistance.

NOTES ON THE GEOLOGY OF LAKE ST. CLAIR AND ITS NEIGHBOURHOOD.

Mr. R. M. JOHNSTON, F.L.S., read an elaborate paper under this title "together with a brief review of the probable origin of our numerous lakes and tarns." He dealt especially with the previous paper, and said it would have been better if Mr. Officer had given new work rather than what had already been better contributed 33 years previously by Mr. Gould. Apart from the unrivalled beauty of the scenery, there was nothing peculiar in the geological features of Lake St. Clair and its immediate neighbourhood which was not common to, and far more perfectly represented by, nearly all the elevated greenstone mountains and plateaux, forming the most familiar physiographic features of the greater part of Tasmanian landscape. From long observations he had arrived at the conclusion that our larger lakes on the higher levels of greenstone plateaux, such as Lakes St. Clair, Sorell, Echo, Arthur, and the Great Lake, together with innumerable lakelets and lagoons, had been mainly determined by the original irregularities of surface, produced partly by the anastomoses of successive flows of greenstones during their eruption, and partly by the unequal contraction due to the lack of homogenity of the cooling surfaces of the more massive horizontal flows of greenstone magnia so characteristic on the mountain plateaux of Tasmania, and which cover continuously, or in an anastomosing network of ranges, so large a portion of the superficial area of eastern Tasmania. This conclusion had again and again been forced upon his mind by the closer study of our upland lake systems, as it seemed to account satisfactorily for all the known facts, and, moreover, it was in harmony with the views of leading physicists when contemplating the causes which produced the initial and universal irregularities of surface on our globe, and which in their turn determined the limits of land and sea.

NOTES ON SOME NEW AND RARE FISH.

Mr. A. MORTON described a new fish, found at Bruny Island. Dr. Ramsay, Curator of the Australian Museum, considered the Bruny Island specimen very similar to *Centrina salviani*. Mr. Ogilvy, however, after a special examination, came to the conclusion that the Tasmanian specimen might fairly be differentiated from the Mediterranean and Eastern Atlantic *C. salviani*. Mr. Morton, therefore, proposed to call the local specimen *C. bruniensis*.

Mr. MORTON also drew attention to six rare fish that had been recently caught off Tasman Island, in 70 fathoms, by some fishermen, while fishing for trumpeter. On examination they proved to be *Euremetopos johnstonii*, the type specimen he (Mr. Morton) had described in 1887.

MISCELLANEOUS.

The SECRETARY laid on the table the fourth volume of the "Journal of the Australasian Association for the Advancement of Science," and said that as editor of the journal he considered it his duty to ask for the thanks of the Society to Messrs. Strutt, Grahame, and Hogg, of the Government Printing Office, and the department generally, for the valuable assistance they had rendered in its production. The volume was greater than the three preceding ones, and contained a great number of valuable papers.

Mr. JAMES BARNARD seconded the vote of thanks, which was carried.

The SECRETARY laid on the table "The Proceedings of the Royal Society of Tasmania for 1892," and a volume lent by Messrs. Walch and Sons on "The Great Barrier Reef," by Mr. Saville Kent.

Votes of thanks were accorded the contributors of papers and donors to the Society, and the meeting terminated.

AUGUST, 1893.

There was a large attendance of the Fellows of the Royal Society on August 15th, and many ladies were also present, to welcome the new President, His Excellency Viscount Gormanston, K.C.M.G., on the occasion of his taking the chair for the first time at one of the monthly evening meetings. The President, who was accompanied by his Private Secretary (Mr. J. F. Alexander Rawlinson), was received by the Council, and on taking his seat,

Mr. JAMES BARNARD said:—"Your Excellency,—I have the pleasing duty as senior Vice-President, on behalf of the Council and Fellows of the Royal Society of Tasmania, to present an address of congratulation to Your Excellency upon receiving the appointment of Governor of Tasmania as Her Majesty's representative. And I have also to tender a hearty welcome to Your Excellency upon your presence here this evening, and upon your assuming the chair of the Royal Society as its official president. From your Excellency's wide experience, gathered in various spheres of official life in the service of the Crown, the hope is entertained that, after the example of many of your distinguished predecessors, your Excellency may be inclined to communicate to the Society, at its monthly evening meetings, the fruits of your observation and remarks in other and different climes as to be eventually embodied in the printed transactions of the Royal Society." (Applause.)

The SECRETARY (Mr. A. Morton) read the address:—

To His Excellency the Right Honourable VISCOUNT GORMANSTON, Knight Commander of the Most Distinguished Order of Saint Michael and Saint George, Governor and Commander-in-Chief in and over the colony of Tasmania and its dependencies. May it please Your Excellency,—We, the Council and Fellows of the Royal Society of Tasmania, desire to offer our loyal congratulations to Your Excellency on assuming the Government of Tasmania as representative of Her Most Gracious Majesty. In 1844 Her Majesty signified her consent to become patron of the Society; and by one of its fundamental rules and constitution, the Governor for the time being is the President. We believe that it will interest Your Excellency to learn that the Royal Society of Tasmania, founded by eminent pioneers of scientific research, was the first to be enrolled under royal patronage; that it has passed its jubilee; and that its printed transactions comprise numerous volumes of valuable scientific information. Many of Your Excellency's predecessors have taken a warm personal interest in this Society, as shown by their presence at its sessional meetings, and by their contributing to its transactions, and we cherish the hope that it will prove agreeable to Your Excellency to take an active interest in the proceedings of the Society. We trust that health and happiness to yourself, Lady Gormanston, and family will attend the whole period of your administration of the government of this colony. We remain Your Excellency's very obedient servants—(Signed) James Barnard, Vice-president; W. L. Dobson, Vice-president; J. W. Agnew, Vice-president; T. Stephens, Vice-president. A. G. Webster, C. T. Belstead, R. M. Johnston, Russell Young, C. H. Grant, Nicholas J. Brown, J. B. Walker, W. V. Legge, members of the Council. Alexander Morton, Secretary. Hobart, August 15, 1893.

The PRESIDENT said: Mr. Barnard, ladies, and gentlemen—I thank you most sincerely for the very cordial welcome you have given me here as representative of Her Majesty and as Governor of this colony. I have heard, previous to arriving in this colony, a great deal of the transactions of the Royal Society of Tasmania, and of the great good that has been conferred on the colony by it from my predecessor and friend, Sir Robert Hamilton—(applause)—your late President. I feel highly honoured by being permitted to occupy the presidential chair of the Royal Society of Tasmania which, as your Vice-president has just told me, devolves on the Governor of this colony. And I can assure you that during my tenure of that office I will do all in my power to promote the interests of the Royal Society, feeling sure that by so doing I shall be promoting the best interests of this country and the happiness of its inhabitants. (Applause.) I have only further to say that I feel deeply thankful for your kind reference to Lady Gormanston, and I regret that she is not present here, and to myself and family. (Applause.)

CORRESPONDENCE.

Apologies for absence were received from the following members of the Council:—Hon. N. J. Brown, M.H.A.; Colonel W. V. Legge, R.A.; and Mr. J. B. Walker.

PROPOSED CONIFERÆ PLANTATIONS.

The following notes were read on the proposed planting of coniferæ in Tasmania :—

By Baron FERD. VON MUELLER, F.R.S., K.C.M.G.:—"With much pleasure, dear Mr. Morton, I respond to the request of the Royal Society of Tasmania, as moved by your distinguished Fellow, Mr. R. M. Johnston, and supported by the Hon. N. J. Brown, that I should, along with our able friend, Mr. Abbott, give my opinion on the advisability of growing the *Pinus silvestris* on a commercial and industrial scale in Tasmania. Your island is undoubtedly particularly well fitted on account of its generally cool climate for the rearing of this pine, as compared to most other regions of Australia. Moreover, in your lowlands the growth will be of more celerity than in Britain, and the same remark applies, of course, to the larch and other trees mentioned at the Royal Society's last meeting. But, as besides the red deal, also the timber of the European white deal (from *Pinus pirla*) is much imported here, that species, as well as the leading lumber pines of North America, would deserve attention for forestral purposes in Tasmania also, thus particularly *Pinus strobus*, *P. douglasii*, *P. lamber tiana;* nor should the vast timber pines of the Himalayas be lost sight of, such for instance as the *Pinus deodara* and *P. excelsa*. Several other species of prominent timber value are mentioned in my work on 'Select plants for industrial culture and naturalisation, with notes as to their respective properties.' *Pinus insignis* has never been recommended by me for any value for its wood, but in wild climes is unsurpassed for its quickness of growth, it towering now in Melbourne already over high buildings, after I reared this splendid pine first of all in Australia for extensive distribution already in the fiftieth year of this century, its importance for shelter and sanitary purposes having since then also been recognised. When pine plantations are to be formed for future profitable timber fields, several considerations press on attention at the outset. 1. To adopt precautionary arrangements for the safety of the trees against bush fires, therefore localities not too dry but intersected also by water-courses. 2. To choose only land which by inaccessibility or sterility cannot become readily arable. 3. To have the means of removing the timber finally at easy carriage, which may be partly by floating the wood down streams. In a discourse which I delivered 25 years ago on 'Forest culture in relation to industrial pursuits' (of which I send you already a Californian reprint), I have alluded to many other subjects concerning intended tree plantations for timber, so that I here now perhaps only need add the suggestions, that official applications be made to the Governments of Canada and British India for adequate supplies of pine seeds of the requisite kinds. The extreme scantiness of coniferaceans in the native vegetation of Australia renders also the New Zealand kauri all the more eligible from their respective territories."

By Mr. F. ABBOTT :—"I entertain no doubt but that favourable sites exist in the colony suitable for the extended cultivation or growth of the various species of coniferæ, which for the most part furnish the deals of commerce, and that eventually great benefit would accrue to the colony from the undertaking. But before entering upon a work of this description it would be essentially necessary that some proper organisation should be formed for the purpose of carrying successfully the work in hand. To be of any commercial value large tracts of land would have to be operated upon, which would entail proper forest conservancy, not alone for the selection of the most suitable species for the various soils and districts, but also for the due protection of the plants in their early stages from fire, browsing of animals, and other dangers, and later on provision would have to be made for systematic thinning of the species and general arrangement. In all forest culture the benefits to be derived are indefinitely deferred, and on this account private individuals seldom enter on the work to any extent, and it therefore becomes essential that the initiatory steps should be by the Government as a national undertaking. As a rule the larger kind of coniferæ, grown for timber purposes, do not thrive on the lowlands, but always remain stunted and of little commercial value, but at an elevation of about 1,000ft. the growth would be much more satisfactory, and good results would be obtained. *Pinus silvestris* would probably require a higher altitude, as it is always of stunted growth on the lowlands or plains. The larch also would thrive at a higher altitude, as frequently on the plains it dies out during drought. The Soltara, *Dammaris australis*, would require a moist situation for successful culture; it is generally stunted in growth when fully exposed on the lowlands. In the event of any effort being made to start the forest culture of soft-wooded trees, the following should be given a trial, as they are all valuable, and for the most part of large growth, and would be likely to give good results on suitable soils. *Abies excelsa*, the Norway spruce, white deal or Baltic fir of commerce, good, lofty, of fast growth and hardy. *Abies menziesii*, good timber tree. *Abies douglasii*, the red fir, a good large tree producing good spars. *Sequoia sempervirens*, the redwood, large, of quick growth, suitable for wet ground. *Pinus strobus*, the white pine, said to be of quicker growth than the larch, good. *Pinus resinoser*, Canada, red pine, said to be one of the best timbers. *Pinus silvestris*, the Scotch pine, also Russian and Baltic pine, good on suitable soils. *Pinus austiaca*, good for moist ground. The following should also find a place in forest culture, being of good commercial value:—The black walnut, *Juglans nigia*, good for cabinet work. The American hickory, the ash, and elm, for coachbuilders' work, and also the white poplar, and Cork oak. *Pinus insignis* appears generally to be held in bad repute by many, but, according to the report of the Woods and Forests Conservancy of South Australia for 1891, this tree has been unfairly condemned. Trees of 10 years' growth, grown on poor sandy soil, were cut up, and various articles manufactured from the timber—tables, ladders, and fences—all of which have been thoroughly tested, and compare advantageously with articles manufactured from imported deals. The timber takes a good polish, and requires less dressing with the plane than other deals, and is very tough and not liable to split on exposure. The difficulty of splitting this timber is said to be the reason why it has been unfairly condemned. As *Pinus insignis* is one of our fastest growing trees—not over-particular as to soil and situation, and becomes of commercial value in less time than any other species, I would consider it indispensable for extended planting where a quick return would be a consideration."

By Mr. A. HARLEY:—"I quite agree with Mr. Grant *re* introduction of larch, but not to the exclusion of the other trees mentioned. Scotch fir might also be included; it makes splendid boat-boards, and I have it from reliable authority that larch trees 16 years after being planted out have been cut into staves for herring barrels. The bark of the larch is also used for tanning purposes. The price was not exaggerated."

Colonel **Legge** contributed some appropriate and suggestive remarks on the subject.

By Mr. A. O. **Green**, who, in some valuable remarks on "Useful coniferæ for Tasmanian planting," said we had in this colony four very useful and valuable varieties of indigenous pine timber trees:—*Sacrydium franklinii*, Huon pine, a timber of the first rank for all purposes, either wet or dry; habitat, moist alluvial flats. *Arthrotaxi cuprusoides*, King William pine, a magnificent wood for panelling and all joiners' work; found from the Don to Port Davey on ridges. *Frenela ventinati*, Oyster Bay pine, a very strong, durable wood, suitable for masts, telegraph poles, and framing; found on the East Coast on poor gravelly soils. *Phyllocladus rhomboidalis*, celery-top pine, another very strong wood remarkable for the small amount of its shrinkage, fit for floor boards and framing of all kinds. With the exception of the Huon pine, all these timbers might be said to be unknown in the workshops of the island, although of the very best quality for their several purposes. All come readily from seed, or might be transplanted when young, and would flourish upon most soils if not holding stagnant water. Thus a very useful work might be done in systematically planting our own very valuable indigenous trees in more accessible localities than those in which they were now found, and in preserving the natural thickets of young trees from destruction by fire or by the trampling of cattle. Besides these, however, it would be most advantageous to the colony to grow other classes of coniferæ, the timbers of which now had to be imported. The most useful were:—*Pinus silvestris*, Scotch fir; *Pinus laricio*, Corsican pine; *Larix europœa*, the larch; *Pinus cembra*; *Pinus pinaster*, the cluster pine. These would all grow upon any soil except pure clay. Mr. Green concluded an exceptionally able paper by urging the desirability of securing the co-operation of the various Government departments in the planting of coniferæ.

A lengthy discussion followed, in which Hon. C. H. Grant, M.L.C.; Messrs. Russell Young, A. Mault, R. M. Johnston, and Fincham took part.

The **President** said that when he undertook the presidential chair he did not expect to have to often open his lips in such a learned and scientific Society, for he saw from some of its transactions that they dealt with astronomy, and he honestly confessed that he knew very little about such things. (Laughter.) But by a curious coincidence the subject the Society was now considering was one that he had taken for many years the greatest pleasure and delight in during all his travels, and they had been pretty extensive. (Applause.) In Japan they looked upon him as a kind of harmless lunatic because he always went about with a tape, and whenever he came to a big tree wanted to measure it. (Laughter.) He gave the Society a lengthy description of personal experience and observation in conifer growing. In summarising his views he said it appeared to him that while considering the propriety of introducing new trees, it would be a greater advantage to the colony to preserve its own timber, and the attention of all parties should be to propagate the excellent timber the colony now possessed and increase its productiveness. (Applause.)

WOLFRAM AND NICKEL.

Mr. Adolphus Oppenheimer communicated some notes on the minerals wolfram and nickel, and in his remarks said: A great revolution in the demand, supply and value of nickel was wrought by the discovery of nickeliferous ores in New Caledonia. The price came down to 4s. per lb. and even less, but many other uses were found for it. The New Caledonian ores average from 8 to 12 per cent., much being lower. A further revolution took place by the discovery of an enormous deposit at Sudbury, Ontario, Canada, and the price now stands at 1s. 9d. per lb. But very large quantities of nickel are now required to make the nickel steel used for armour plates in war ships, and for other war material." With regard to the Tasmanian nickel, found near the Heazlewood River, Mr. Oppenheimer said:—"A bulk sample, which has been assayed for me by Mr. Frederick Danvers-Power, of Melbourne, gave the astonishingly rich result of 35·1 per cent. of nickel. The nickeliferous belt appears to have a north to south strike, and can be traced for a distance of about two miles; the width of the belt, so far as can be seen, is from 600ft. to 1,000ft. wide. The mount is of serpentine rock formation, about 700ft. high, and on the northward side of the Heazlewood River. It is surprising to me that, although this deposit of nickel ore has been known to exist for some years past, nobody before me ever recognised its value. Indeed, I am informed that some of the local geologists mistook the sulphide of nickel for mispickel, which it somewhat resembles in appearance, and one so-called authority went so far as to assure me that the very best nickel ore that could be found at Heazlewood did not contain more than 7 per cent. of nickel. That the nickel contents in the ore by far exceed the 7 per cent. so much mentioned to me as 'the very best,' is proved beyond doubt by the bulk assay, which gave the astonishing result of a little over 35 per cent. of nickel! I believe when this mine is opened up large ore bodies averaging 20 per cent. of nickel will be obtained, and it is certain that this mine will prove in the near future to be of immense value. As I believe I have been the first to recognise the value of the ore and of the deposit, and also intend to work it and be the first exporter of nickel ore from Tasmania, I think that I have not overstepped the bounds of vanity, if such there be, in naming the mount on which it is found, 'Mount Oppenheimer,' after my wife."

Hon. P. O. Fysh, M.L.C., proposed a vote of thanks to the President for taking the chair.

The President, in acknowledging the compliment, said it would always be a pleasurable duty to preside over the Society's meetings. At the same time they were not to expect him to speak on all occasions. He made it a rule never to speak on subjects he knew nothing about, and they would find that he could maintain a dignified silence. (Laughter and applause.)

A vote of thanks to the authors of the various papers concluded the proceedings.

SEPTEMBER, 1893.

There was a large attendance of Fellows and ladies at the meeting of the Royal Society on Tuesday, 12th September. The following telegram was read from Lord Gormanston's Private Secretary:—"Governor regrets that he cannot preside at meeting to-night." Sir Lambert Dobson was therefore voted to the chair.

Sir R. G. C. Hamilton, K.C.B., LL.D., a distinguished patron and promoter of the objects of the Society, was elected an honorary member. Mr. Robert Kidston, F.R.S.E., F.G.S., of Edinburgh, was elected a corresponding member. Messrs. W. A. Harvey, M.R.C.S.E., and J. N. Propsting were elected Fellows.

NOTES ON MOUNT LYELL.

"Notes on the Mount Lyell mine." By E. D. Peters, jun., M.E., M.D.

Some remarks on the paper were made by Messrs. R. M. Johnston, W. F. Ward, A. O. Green, C. H. Grant, T. Stephens, and the Chairman. All agreed that the paper was able, highly interesting, and very valuable. Mr. Johnston found a difficulty in reconciling Dr. Peters' statement that the mineral deposits at Mount Lyell were effected by small streams when he did not allow that pyrites were soluble. Mr. Grant urged that the commercial value of Mount Lyell should not be overrated, and pointed to its comparative unfavourable position for economic working.

The SECRETARY (Mr. A. Morton) drew attention to some specimens of ore from Mount Lyell, and read the following result of three days' work at the mine on August 28, 29, and 30, the information having been forwarded to the Treasurer (Hon. John Henry), whose Parliamentary duties prevented his presence:—"Raised 21 tons 3cwt. ore; assayed 1,432oz. silver and 24 per cent. copper, equal to 32,288oz. silver and 4 tons copper in the 21 tons 3cwt. of ore; worth roundly £4,000 for three days' work. The rich vein is now 6ft. thick."

TAXATION AND COST OF LIVING IN TASMANIA.

Mr. R. M. JOHNSTON read an elaborate inquiry as to the varying proportions of food and other articles embodied in "Cost of Living," in relation to average income; together with observations relating to the proportion which taxes on food and other articles bear in relation to the total taxation of various countries. He said that the cost of living in every country was almost as variable as the widely varying fortunes of classes and individuals. It varied with the average wealth and standard of living of countries as well as of individuals. Mulhall estimated the average income per head of 18 great countries at £20 8s. per inhabitant. The average absolute cost of living in Tasmania he estimated at £11 10s. 7d. per head, or 32·14 per cent. above the average. As a doubt had been expressed recently by a very accomplished thinker whether sugar and tea contributed less to local taxation than clothing, a careful re-examination of the matter had been made, with the result of confirming unmistakably, so far as Tasmania was concerned, that not only was the amount of taxation per head in Tasmania less for tea and sugar than for clothing by 21·98 per cent. on an average of three years, but that also the total cost of tea and sugar, including taxes (cost of living) on the average only amounted to £1 13s. 7d. per head, or 3·53 per cent. of average income per head; while clothing, as an important and more necessary element in the "cost of living," averaged about £6 19s. 10d. per head in Tasmania, or 14·72 per cent. of average income per head, viz., it exceeded the total cost of tea and sugar together by £5 6s. 3d., or fully four times the amount. The question was thus narrowed down to a small issue, viz., whether it would be more easy, for the poorer classes, to impose an additional tax of 6s. per head on clothing, raising it to 14s. per head, or to impose an additional tax of 3s. 11d. on tea and sugar, raising the existing tax to 10s. 2d. per head? It was clear, if no other qualification could be established, that the *ad valorem* tax in its effect on clothing would take about 2s. 1d. per head more from the poorer classes than the alternative tax upon tea and sugar. The paper was accompanied by a series of tables, illustrated by a diagram, and concluded with a hope that the facts set out might be of service to all practical economists and statesmen who might have to deal with matters affecting "the cost of living" of the people of this colony. He allotted Tasmanian expenditure based on the mean of three years, as follows:—Sugar and tea, £242,308; other food, £1,421,523; total food, £1,663,831; clothing, £1,009,064; rent, houses, £665,241; drink, £544,219; tobacco, cigars, £72,158; sundries and residue, £2,885,555. Total expenditure, £6,840,068.

MISCELLANEOUS.

Mr. T. STEPHENS' paper, giving additional information respecting coniferæ planting in Tasmania, was postponed, but Mr. Stephens produced specimens of the celery-top pine, also two other specimens to demonstrate the difference between the King William pine and the red pine.

Mr. A. O. GREEN also produced a specimen of the celery-top pine, as well as others of local hardwoods sunk for years in the railway bridge at Bridgewater, to prove their durability.

Votes of thanks to the contributers of papers terminated the proceedings.

October meeting was not held.

NOVEMBER, 1893.

The monthly meeting of the Royal Society was held on Tuesday, November 14 An apology for absence, caused by a previous engagement, was read from His Excellency Lord Gormanston. Sir Lambert Dobson was voted to the chair.

CONIFERÆ PLANTING

"Further notes on coniferæ planting in Tasmania, by Mr. T. Stephens, M.A., F.G.S" The paper dealt historically with previous attempts that had been made, in some cases with great, and in others with moderate, success, to plant coniferæ in the colony. As the result of some planting experiments by the late Mr. Joseph Archer at Panshanger, in 1821, four firs grown from seed now remained, the largest being 11ft. 2in. in girth, and the others 10ft. 7in., 9ft. 10in., and 9ft. 4in., with heights of from 70ft. to 80ft. Four other old fir trees from the first sowing were cut down 30 years since, and the boards in a room floored with them were as sound as the day when they were put down. The *Pinus insignis* was the most rapid growing tree. One planted about 25 years was 13ft. in girth and another 10ft. The largest was in sandy loam, and the other in gravelly soil. Amongst those who did much to encourage the planting of foreign trees in the early days were the late Mr. James Denton Toosey, Mr. William Gibson, of Scone, the late Mr. George Meredith, and particulars were given of many of the trees they planted. Mr. Stephens feared that the industry was one to be left to private enterprise, for it would be idle at present to ask the Government to renew the attempt to establish a department of forestry. Something might, however, be done to protect the more valuable indigenous trees from premature destruction, and encouragement might be given to the cultivation of useful timber trees by leasing suitable tracts of the waste lands of the Crown at a peppercorn rent, on the sole condition that they should be occupied and used only for that special purpose.

Mr. **Stephens** explained that the information was collected hurriedly for use when the subject first came before the Society some months ago. With more time no doubt it could be greatly supplemented.

Hon. C. H. **Grant**, M.L.C., and Mr. O. E. **Green** made some remarks on the question dealt with.

NORFOLK ISLAND.

Mr. J. B. **Walker** read some "Further Notes on Norfolk Island," sketching the history of the failure and abandonment of the island as a penal settlement, and the transportation of the inhabitants to Tasmania.

Mr. **Stephens** said that the Society was again indebted to Mr. Walker for adding another chapter to the history of Tasmania, and he had no doubt that in time to come it would be embodied in some important work other than the proceedings of the Royal Society. (Hear, hear.)

BOTANICAL NOTES.

Mr. L. **Rodway** contributed a paper dealing technically with one or two plants previously brought before the notice of the Society, but chiefly with plants new to science and Tasmania, with details and descriptions, and going on to allude to some changes in the nomenclature of some of our common plants.

MISCELLANEOUS.

The **Secretary** (Mr. A. Morton) drew attention to the large and valuable collection of mammals and birds received from the Royal Museum at Florence, and mentioned that Professor Giglioli, who sent them, had some 30 years ago written a book on the Tasmanians, and although he now had but one copy he was determined to procure another and present it to the Royal Society. (Applause.)

On the motion of the Hon. C. H. **Grant**, a unanimous vote of thanks was passed to Professor Giglioli.

Sir **Lambert Dobson** proposed a similar compliment to the contributors of papers

A CATALOGUE OF THE MINERALS KNOWN TO OCCUR IN TASMANIA, WITH NOTES ON THEIR DISTRIBUTION.

BY W. F. PETTERD.

THE following Catalogue of the Minerals known to occur and recorded from this Island is mainly prepared from specimens contained in my own collection, and in the majority of instances I have verified the identifications by careful qualitative analysis. It cannot claim any originality of research, or even accuracy of detail, but as the material has been so rapidly accumulating during the past few years I have thought it well to place on record the result of my personal observation and collecting, which, with information gleaned from authentic sources, may, I trust, at least pave the way for a more elaborate compilation by a more capable authority. I have purposely curtailed my remarks on the various species so as to make them as concise as possible, and to reduce the bulk of the matter. As an amateur I think I may fairly claim the indulgence of the professional or other critics, for I feel sure that my task has been very inadequately performed in proportion to the importance of the subject—one not only fraught with a deep scientific interest on account of the multitude of questions arising from the occurrence and deposition of the minerals themselves, but also from the great economic results of our growing mining industry. My object has been more to give some information on this subject to the general student of nature,—to point out the large and varied field of observation open to him,—than to instruct the more advanced mineralogist.

Our minerals present a somewhat remarkable and interesting admixture of species, many of which are usually looked upon by mineralogists as restricted to certain well known and recorded localities, such as Crocoisite and Vauquelinite, which have until recently been considered as almost peculiar to the mining districts of Siberia; twò of our comparatively common forms—Zaratite and Huastolite—have scarcely been recorded outside their original localities in North America, while Matlockite and Leadhillite are well known British minerals, and Pleonaste and Zircon are abundant in Ceylon. This association of species would appear to some extent to confirm the existence of areas of great economic value containing the same metallic and other minerals that are characteristic of the older and better known mining countries. A comparison of the number of mineral species herein enumerated, with the catalogues that have been compiled of those known to occur in the various Australasian colonies, may be of some interest, as illustrating in a forcible degree the mineral wealth of this island, notwithstanding its restricted area and the paucity of investigators in this special department of science.

It will be found that in New South Wales about 185 species have been discovered (Liversidge, "Minerals of New South Wales," and "Report of the Second Meeting of the Australasian Association for the Advancement of Science, 1890"); South Australia about 100 ("Report of the Second Meeting of the Australasian Association for the Advancement of Science, 1890"); Queensland about 101 (*loc. cit.*); and New Zealand about 172 (*loc. cit.*)

The Report of the Association is not as yet completed, as it does not contain a census of those known to occur in either Victoria or Western Australia: the former may reasonably be expected to enumerate about 100 species. From a somewhat careful examination of the various catalogues that have been published, it may be fairly concluded that this island contains as many mineral forms as have been discovered throughout the whole of the mainland of Australia. Of the minerals that have been discovered here about 40 kinds have not been recorded as occurring in Australia. It will be found that the catalogue not only includes a large majority of the world's economic minerals, such as representatives of the Gold, Silver, Iron, Nickel, Cobalt, Wolfram, Bismuth, Titanium, Lead, Copper, and Platinoid groups, but also many species of considerable scientific interest, one or two of which are apparently new chemical compounds. So far no members of the Selenium, Tellurium, or Uranium groups have been discovered, but there is apparently no reason why they should not exist; their discovery may therefore be reasonably expected as the work of the prospector progresses.

I have to thank my esteemed friends Messrs. James Smith and W. R. Bell—both well known names in mineral discovery—for much kindly help and valuable information regarding the occurrence of many of the minerals here enumerated, and to Mr. A. Morton I am under great obligation for assistance in many ways.

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1. APATITE (*Phosphate of Calcium*).

Occurs of a clear greenish colour with dull lustre in limited quantity in lode gangue. Hampshire Hill Silver Mine; Mt. Bischoff; Maria Island.

2. ARFVEDSONITE.

"A highly ferruginous variety of Amphibole or Black Hornblende," contains one per cent. of copper. "The copper which it contains exists in part or all as oxychloride coating the crystals." (G. Foord.)

Swan Island, Bass Straits. (Gould, Pro. Royal Soc. Tas., 1871.)

3. ALLOPHANE (*Hydrated Silicate of Aluminum*).

The examples are of interesting colouration, which is yellow to brown in water, but blue when exposed. It is somewhat opaque. Occurs in serpentine as a narrow vein from a few inches to above one foot in width.

Harman's Rivulet, under the Parson's Hood (W. R. Bell); near Derby, as a band of a pale waxy-yellow colour.

4. ALIPITE (*a Silicate containing Nickel Oxide*).

Of extremely rare occurrence in small amorphous masses at the Heazlewood Silver-Lead Mine. In colour it is a pale apple-green with a dull lustre. It has also been obtained at the Bell's Reward and Godkin mines in limited quantity.

5. ACTINOLITE (*a green-coloured fibrous variety of Hornblende*).

The radiating variety occurs a few miles south of the Hampshire Hills, up the Emu River. It is found associated with an iron garnet, amethystine quartz, and fibrous radiating iron, which is probably limonite. At the Heazlewood it is plentiful in spreading and radiating acicular bunches of considerable size and greenish colouration. Obtained in large masses on the River Forth, about three miles from Mt. Claude. On the Whyte River, near the base of the Meredith Range, this mineral occurs of a dark asparagus-green colour—much resembling the variety termed Calamite—containing minute bunches of Asbestos and particles of Mountain-cork, the whole closely intermixed with bands of a yellowish-brown garnet rock which often contains Molybdenite. The Mountain-cork is of a spongy and closely interlaced structure, pale brown to brownish-green in colour, and is often much stained with iron oxide.

6. ARSENOPYRITE (*Mispickel*).

Widely distributed, occurring chiefly in lodes in crystalline rocks with various other forms of pyrites. It is very abundant throughout the north-eastern portion of the island, and occasionally contains a small quantity of silver. In the vicinity of the Scamander River it commonly occurs, sometimes in large masses. At Mt. Sorell, on the West Coast, it is abundant in the form of minute but extremely well-formed free crystals in river drift, the crystals showing many beautiful modifications and mackles; at Waterhouse it has been mixed in dense compact masses containing gold in a quartz matrix; at Mt. Ramsay it occurs with other pyrites and native Bismuth in Amphibole—assays of the separated arsenical pyrites made by Mr. Cosmo Newberry gave a return of above three ounces of gold per ton; at Mt. Bischoff and at north-east Dundas it is plentiful, intimately mixed with other pyrites, the whole containing a considerable quantity of Cassiterite,—at the former locality it has been found in a lode formation with Fluor-spar, Sphalerite, and Siderite: it is fairly abundant in auriferous reefs at Mathinna, Lefroy, and Beaconsfield, also Penguin River, Mt. Ramsay, Mt. Heemskirk, Mt. Pelion, and other places.

On the southern slope of Mt. Wellington this mineral is said to occur, containing up to 15 per cent. of Cobalt. It was found intermixed with quartz in a disturbed contact formation occurring between sandstone and altered slate (Dyson Western). This form probably belongs to the sub-species Glaucodot.

7. ADULARIA (*a variety of Felspar, also known as Moonstone*).

Occurs in large crystalline masses porphyritically disseminated in granite and a dioritic rock. . It is usually washy-white, but varies to a pale green colour.

Upper Arthur River; Coldstream Rivulet, a tributary of the Huskisson River; and at the Tasman Rivulet, with quartz of various forms. (W. R. Bell.)

8. ANNABERGITE (*Arsenate of Nickel*).

This is a secondary mineral of an apple-green colour when pure, soft, and commonly massive or incrusting.

Obtained in extremely minute quantity, Penguin River.

9. AUGITE (*a dark-coloured variety of Pyroxene*).

The crystals of this mineral are usually, if not always, stouter proportionally than those of its ally, Hornblende, and they are but rarely much elongated. In the basalt rock they are sometimes fairly developed.

St. Paul's Plains (Proc. Royal Soc. Tas., 1854),—in basalt, the crystals are often nearly half an inch in length; Paddy's Sugarloaf, Emu River; Hampshire Hills, near the Emu River; near Mount Horror, in an intensely black basalt, on the weathered portions of which the crystals stand out from the surface of the rock: they are often very clearly defined.

10. ASBOLITE (*Hydrated Oxides of Manganese and Cobalt*).

This unsatisfactory species (?) has been found at the Godkin Silver Mine, Whyte River, in bluish-black bunches and irregular masses; occurs fairly plentiful at Dundas; Castle Forbes Bay; Magnet Range, in lode gossan with other secondary minerals; Castra, Upper Leven; Penguin River, and other places.

11. ALUNOGEN (*Sulphate of Alumina*).

Often abundant as an effloresced incrustation in caverns occurring in argillaceous rocks.

Occurs near Bridgewater; Brown's River Road; near St. Mary's; Mersey River, about four miles from Chudleigh, known locally as the Alum Cliff; Blue Tier, near Beaconsfield.

12. AXINITE (*Silicate of Alumina and Lime. with Boracic Acid, &c.*)

This rare mineral was detected by Professor Ulrich during his examination of the Bismuth and Gold discovery at Mount Ramsay. It occurs in thin brown patches or blebs in the Amphibole rock, and is comparatively rare. It has not been discovered in Australia.

13. ATACAMITE (*Oxychloride of Copper*).

The beautiful green ore of Copper is occasionally met with in radiating acicular bunches in the vughs of ferro-manganese gossan ore capping the lode on the property of the Comet S.M. Co., Dundas; in small quantity in mixed oxidised ore, Silver Queen, Zeehan; in vughs, Gad's Hill Range, Upper Mersey River.

14. ANDALUSITE (*Anhydrous Silicate of Alumina*).

Abundant in slightly elevated radiating masses of a light colour near the Lottah mine, Blue Tier.

The variety Chiastolite occurs sparingly at Zeehan in Silurian slate-rock as radiating and interlaced prisms of small size.

15. AZURITE (*Blue Carbonate of Copper*).

This beautiful mineral is only known to occur in this island as thin scaly masses, and as extremely minute crystals.

Hampshire Hills; Gad's Hill; Dundas; Zeehan; Mainwaring Inlet; Mackintosh River; Penguin; Saxon's Creek; Cascade; Heazlewood, and other places.

16. ANATASE (*Titanic Acid*).

Occasionally obtained with its chemical congeners Rutile and Brookite. It is usually very much waterworn, but occasionally fairly good examples may be found.

Clayton Rivulet; near the River Forth; near Mount Lyell; in the streams in the vicinity of Brown's Plain.

17. ALMANDITE (*Alumina-iron Garnet*).

In small crystals, which are translucent and of fair colouration, near Mount Heemskirk.

18. ANKERITE (*Carbonate of Lime, Iron, and Magnesia*).

A brown Dolomite containing a considerable proportion of Iron. Occurs on the Heazlewood; Maestrie's Broken Hill Mine at Dundas; North Valley Silver-lead mine at Mount Bischoff, where it forms a black weathered gossan capping a lode, of which it is the gangue; at the Godkin Silver Mine it occurs intermixed with dark-coloured Calcite, both of which often contain Native Silver, Galena, and an amorphous blende.

19. ANTIMONY, NATIVE.

Occurs in minute irregular flakes and patches distributed throughout the silicious gangue of an argentiferous lode on the property of the Hays Prospecting Association, Castray River.

20. ARGENTITE (*Sulphide of Silver*).

Silver Glance is an extremely rare mineral in this Island, the only authentic localities are the Godkin Extended, Whyte River, the Hampshire Silver Mine, at the Hampshire Hills, and Mount Lyell. At the first it occurs in an almost pure state—assaying at the rate of many thousands of ozs. of silver per ton—as worn rounded "slugs" with blocks and masses of Galena and Huastolite in the workings of the mine. The slugs are of small size, rarely exceeding an inch in diameter, and are always coated with a black "pug" formed by the decomposition of various minerals. At the Hampshire Hills it was obtained many years ago in the form of minute crystals implanted upon other minerals and in the cavities of lode material. (W. R. Bell).

It has been recorded as occurring at the Scamander River and at Mount Bischoff (Johnston "Geology of Tasmania.") At Mount Lyell it is found with Chalcopyrite and other minerals plentifully scattered throughout a quartz matrix, which is said to occur as a wide band on the footwall of the enormous mass of interbedded Pyrites for which the locality is celebrated.

21. ASBESTUS (*a variety of Hornblende*).

Following Dana ("A Text Book of Mineralogy, 1885,") I retain this term for the fibrous substance belonging to the Hornblende or Amphibole group: the term is commonly applied to fibrous Serpentine. Occurs in extremely short silky bunches, approaching the variety termed Amianthus, with a form of Actinolite and Mountain-cork, in an adit on the property of the Whyte River Proprietary Prospecting Association, Whyte River. (*See* CHRYSOTILE).

22. ANGLESITE (*Sulphate of Lead*).

As a rule this is not an abundant mineral, except at special localities. From its physical appearance it is usually mistaken for the Carbonate of Lead and called such. The finest examples yet discovered in Australasia occurred in some quantity at the Maestrie's Broken Hill Silver-Lead Mine at Dundas. Many of the crystals obtained at this mine are large and beautifully developed, occurring in masses of considerable size, sometimes containing Massicot in the interstices and as a base. Commonly large lumps of Galena are coated with Anglesite, Cerussite, and Masscot, presenting an appearance that has become fairly characteristic of this mine and the Comet adjoining. This mineral has also been sparingly found at the Whyte River, and at Zeehan. It crystallises in rhombic prisms with pyramidal terminations. This mineral often gives high assay returns in silver, which is held in the form of one or either of the Chloride group. Mr. W. F. Ward states (Tasmanian Official Record, 1892), "Anglesite with Oxide of Iron and Manganese, and yielding up to 480 ozs. of Silver per ton, has been discovered."

23. ARRAGONITE (*Hard Carbonate of Calcium*).

Often found in cavities of basalt as radiating and bunching masses at Lefroy; Mount Bischoff; Sheffield and Springfield. It is stated to occur at Bridgewater and West Tamar; Chudleigh, where it forms stalactites, in the limestone caves of the locality.

24. ARSENIC, NATIVE.

In hemihedral crystallizations with radiated internal structure, colour almost tin-white, tarnishing black.

East Bischoff mine; in lowest level North Valley lode, Bischoff, in blades between laminæ of Siderite with Fluorite, various Pyrites and Black Sphalerite.

25. ARSENOLITE (*Arsenious Acid or White Arsenic*).

A single large lump was obtained at the Devon Consols mine at the Penguin, associated with Arsenical Copper, Melaconite, and a little Native Copper.

26. ASPHALTUM (*Bitumen or Mineral Pitch*).

About four miles from Chudleigh on each bank of the Mersey River. It is perfectly black, sectile, burns with a dense smoke and strong odour. It occurs in a drab-coloured aluminous shale. "A species of, occurs on the north end of Prime Seal Island" (Gould, Pro. Royal Soc. Tas., 1871, page 61).

27. APLOME (*Iron-lime Garnet*).

A Garnet, of various shades of brown, but generally of a cinnamon colour. They occur in great abundance and large size, often reaching above an inch in diameter. When first broken out they are very fine and beautiful.

Hampshire Hills and on the banks of the Upper Emu River.

28. ANORTHITE (*a white Silicate of Alumina and Lime*).

Whyte River, in limited quantity.

29. BITUMINOUS SHALE.

Argillaceous shales of a more or less bituminous character and of various shades of brown and black occur at several places. They are all inflammable to some extent; so far they have not been determined.

Ben Lomond; Dilston; Beaconsfield; Piper River; George Town; Heazlewood; Blue Tier; Inglis River; Gad's Hill; and other places.

30. BEAUXITE (*Hydrated Oxides of Alumina and Iron*).

A substance from Port Davey, agrees fairly well with the general characteristics of this mineral, although the identification is doubtful.

31. BOURNONITE (*Sulphantimonite of Lead and Copper*).

Occurs in patches near the junction of the slates and granite on the south-east shores of King's Island (Gould, Pro. Royal Soc. Tas., 1871).

32. BERYL (*Silicate of Alumina and Glucina*).

The true emerald has not so far been found here, but hexagonal prisms that are colourless to bluish-green have been obtained at Flinders Island, also in stanniferous drift as water-worn pebbles at Mount Cameron. At the last locality a fairly good example was obtained some years back. It consisted of portion of a crystal about an inch in diameter and the same in length. It had the true hexagonal form and characteristic cleavage. The colour was dull green with a translucent appearance. The stone was mistaken by the miners for a peculiar form of Copper ore. More recently another specimen was obtained in the drift of almost the same colouration, rather less in diameter, but nearly three inches in length.

33. BRONZITE (See ENSTATITE).

34. BASANITE (*variety of Quartz*).

This is the Lydian or touchstone, a compact black quartz. The stone was used for testing the purity of gold by rubbing the metal upon a smooth surface, the colour of the streak indicating the amount of impurity.

Swansea; Conara.

35. BROOKITE (*Titanic Oxide*).

This species is of the same composition as the more abundant Rutile, but crystallizes in the orthorhombic system. It occurs with it and Anatase at Clayton's Rivulet, also near the Pieman River, and at Back Creek, near Lefroy: at the last locality it is found in flakey pieces, which are blood-red in colour by transmitted light.

36. BRUCITE (*Hydrated Magnesian Oxide*).

The common character of this mineral is massive and foliated, with a somewhat pearly lustre. It is invariably found in or near Serpentine. Occurs in large masses at the Heazlewood; in hexagonal plates which are embedded in Serpentine, Lower Castray River; common west of Beaconsfield; Mt. Heemskirk, foliated and partly altered to Hydromagnesite. (Ballarat School of Mines Museum.)

37. BISMUTHENITE (*Bismuth Glance*).

In small irregular particles in Amphibole with the native metal, Mt. Ramsay. A fine mass of this mineral was met with in the workings of the West Cumberland mine at Heemskirk. Stated to occur at the Blue Tier in granite and at Mt. Reid with Fluor-spar and metallic Bismuth in quartz. At the Iris River, Middlesex, this mineral has been discovered in a lode or vein associated with Cassiterite. Much of the exposed portion is altered to carbonate.

38. BIOTITE (*Magnesia Mica*).

Abundant, often of a greenish colour, Mt. Heemskirk; the frondose variety has been found at the North Pieman River; in large plates and masses at Flinders Island and on the north-eastern coast; common near the Hampshire Hills, many of the flakes measuring half an inch across; Blue Tier and other places. This form of Mica may be distinguished from Muscovite, in a general way, by its darker colour.

39. BERTHIERITE (*Sulphide of Lead and Iron*).

Usually of a dark steel grey colour with a metallic lustre and irregularly striated surface.

On the west flank of Mt. Bischoff the mineral occurs as a compact lode closely intermixed with granular quartz. It contains a small amount of silver.

40. BOULANGERITE (*Sulphantimonite of Lead*).

Occurs near Waratah with Siderite and Mariatite in a lode, the gangue of which is Fluor-spar and quartz.

The samples vary in structure to some extent; they are commonly fibrous and compact, but often graduate to a form which is almost granular, the lustre is invariably silky and metallic. At Dundas it occurs both fibrous and massive, and is often associated with Jamesonite, Pyrites, Cerussite, and Massicot.

41. BORNITE (*Sulphide of Copper and Iron*).

Also known as Purple Copper Ore. Occurs massive and of good colouration, Mainwaring Inlet, West Coast; fairly common with Cassiterite and other minerals, Star of Peace Mine, Cascade River; occasionally occurs in limited quantity in stanniferous dykes, Blue Tier.

At Mt. Lyell this mineral occurs in a highly argentiferous form—often giving assay returns as high as 2000 oz. of silver to the ton of ore; it is also to some extent auriferous.

Argentiferous Bornite is of very unusual occurrence; but a similar combination occurs at the Red Mountain, Colorado, U.S.A., where it is also associated with Stromeyerite and Fahlerz.

42. BISMITE (*Oxide of Bismuth*).

Of very rare occurrence. It is found as a thin yellowish earthy coating on other Bismuth minerals at Mt. Ramsay; in arborescent crystal groups, occurring in the cleavage planes of country rock; colour of a greenish-yellow. Hampshire Silver Mine (W. R. Bell.)

43. BISMUTITE (*Carbonate of Bismuth*).

Usually occurs in whitish to yellow amorphous and pulverulent masses with other ores of the same element, and sometimes as waterworn nodules in alluvial drift. Here it is of unusual rarity, having so far only been obtained in minute coatings and blebs at Mt. Ramsay, Mt. Reid, and the Hampshire Hills. Said to be occasionally met with in drift with gold and Native Bismuth at the Ring River; has been found somewhat plentiful in stanniferous drift as small waterworn slugs. Iris River, near Middlesex. At this locality it has recently been discovered *in situ* in a small lode or vein intermixed with quartz and the sulphide of the metal.

44. BISMUTH, Native.

Abundantly distributed throughout a sub-crystalline black Hornblende or Amphibole of massive structure that occurs as an extensive lenticular formation at Mt. Ramsay. The metal is freely distributed in small irregular particles and flakey masses, varying in size from microscopic grain to pieces weighing several ounces. It occurs associated with blue and white Fluor, Scheelite, and Axinite, with the metallic minerals Pyrrhotite, Chalcopyrite, and Pyrite. The mass of Hornblende occurs as a contact formation abutting upon Granite on the one side, and a Dioritic rock on the other. At Mt. Reed this metal has been discovered in quartz with Fluor; it has also been obtained at the Blue Tier in granite in a lode or dyke with Cassiterite and Molybdenite. Some of the alluvial gold obtained at the Ring River is said to contain this metal as an alloy; it would therefore approach the substance that has been named Maldonite. Although Bismuth is commonly auriferous it is not so at Mt. Ramsay; the gold at that locality was obtained from Chalcopyrite and Mispickel.

45. BARITE (*Sulphate of Baryta or Heavy Spar*).

Occurs at many localities throughout the north-western portion of the island. It is very plentiful at the Surrey Hills, where it often contains Copper Pyrites and minerals resulting from the decomposition of the same, such as black oxide and the carbonates. At Mt. Lyell it occurs with Gold in large compact masses; in veins under Mt. Roland, Rocky River, and near Corinna, Pieman River; at the Wilmot River, where Native Copper is found associated with it; at the Specimen Reef Mine, Savage River, often containing cupriferous pyrites and sometimes Gold; with galena, Huskinson River; with Pyrites and Galena, near Deloraine; with Calcite, Siderite, and Galena, on the banks of the Upper Leven River.

46. BASTITE—see SCHILLER SPAR.

47. BLENDE—see SPHALERITE.

48. CHALCOPYRITE (*Sulphide of Copper and Iron*).

Much of the mineral substance known under this name is more properly Cupriferous Pyrite, the pure chemical compound being comparatively rarely met with. It is the common ore of Copper, which here, as in most other metalliferous countries, is freely distributed, although the crystallized pure form is but rarely seen. Although copper, probably this ore, was known to exist in the island as far back as 1822 (Evans' Description of Van Diemen's Land), no profitable results have followed the few attempts that have been made to open up the discoveries of the ore at Mount Maurice, Badger Head, Saxon's Creek, &c. All have been abandoned after the expenditure of a limited amount of capital, so that the real value of these deposits still remains an open question. The more important localities are:—Mackintosh River, with Baryta and Calcite; Mainwaring Inlet; Cascade River, with Cassiterite and Schorl; Mount Ramsay, auriferous in Hornblende; Badger Head; Frankford; Mount Lyell, with Galena and other minerals; Penguin River; Lake Dora; Beaconsfield; Mount Maurice, with Cassiterite and crystallized Quartz; Mount Heemskirk; Arthur River; Scamander River, with Galena, Blende, and Arsenical Pyrites; Blue Tier; near George's Bay; Bell Mount, west of Mount Claude, where it occurs in rather large quantity as rounded lumps in alluvial drift with free gold; occurs in a lode at Mount Bischoff with Mariatite, Berthierite, and Chlorophane.

49. CANNEL COAL (?)

An important discovery has recently been made of a bituminous substance bearing a very close physical resemblance to the valuable Cannel Coal of England and Scotland. It was found in the form of loose surface blocks—supposed afterwards *in situ*—by the prospectors sent out by the Mole Creek and Zeehan Mineral Prospecting and Exploration Company, Limited, at Barn Bluff, near Mount Pelion.

Mr. T. Bateman, the secretary of the Company, has kindly placed specimens of the substance at my disposal, as well as allowing me the privilege of making extracts from several interesting reports thereon. The substance is of a very compact nature, with a distinct and broad conchoidal fracture in all positions, shining intensely black, with a pitch-like appearance; brittle and sectile, with a dull black streak. It is easily ignited, burning with a clear flame, and gives off a strong odour. It has been critically examined, and careful analysis made by several well-known authorities, all of which tend to prove that, if not exactly identical with the typical form of Cannel Coal, it is at least very closely allied to it both physically and chemically. Mr. J. Cosmo Newberry, in a report upon its chemical composition, states that, "Upon analysis it gave the following results :—

Water at 212 °/o	trace.	
Volatile matter	54·20	per cent.
Fixed carbon	39·75	"
Ash	6·05	"
Total	100·00"	

Mr. W. F. Ward, Government Analyst, under date 29th Sept., 1892, gives the following result of an examination: "The Cannel Coal received from you has the following ultimate composition :—

	Per cent.
Carbon	74·0
Hydrogen	7·8
Oxygen and Nitrogen	12·8
Sulphur	0·8
Ash	4·2
Moisture	0·4
Total	100·0

The proximate composition is :—

Fixed carbon	44·3	Coke, 48·5 per cent.
Ash	4·2	
Gases, &c. lost at red heat	51·1	
Moisture	0·4	
Total	100·0	

The sulphur is included in the 'coke' and 'gases;' the coke is firm and lustrous, and the gas would be of great value for enriching that of poorer coal. The *ultimate* composition is almost identical with that of 'Grahamite,' which is described by Dana as 'an oxygenated and inspissated petroleum, found in shrinkage fissures in sandstone,' but the physical characters of the two substances are different.—The specific gravity of the sample is 1·13."

Mr. T. S. Cleminshaw, Engineer of the Launceston Gas Company, states, "*In re* sample of Cannel Coal supplied, I have tested it for quantity and quality of gas, with the following results :—

Quantity (average of 4 tests)	11·200 cubic feet per ton.
Quality (average of 3 tests)	50·40 candles corrected for barometer and thermometer."

The true Cannel—a corruption of the word "candle"—is a variety of bituminous coal. It is compact in structure, with little or no lustre, breaking with a conchoidal fracture, and somewhat smooth surface; colour dull black. It affords a large quantity of burning and lubricating oils with other products, and is of considerable economic importance. A variety is known as Torbanite (Boghead Cannel), which is of a brown colour without lustre, and gives a yellowish streak. It may be stated that "Parrot Coal" is a Scotch term for Cannel.

The arrangement of the various Hydrocarbons of the Cannel character appears to be extremely unsatisfactory, and the utility of an arbitrary specific classification is very doubtful, more especially as the majority appear to fairly agree both as regards physical and chemical character. For commercial purposes local appellations are convenient, and the variety discovered in this colony will doubtless, in due course, receive one by which it will be known from analogous substances. I would suggest that it be termed "Pelion Coal" or "Pelionite."

As an illustration of the difficulty of the scientific arrangement of this class of mineral on a satisfactory basis, the following remarks by Professor A. Liversidge ("The Minerals of New South Wales," page 145) may be interesting. Referring to the New South Wales Torbanite (Wollongongite) or Kerosene Shale, this learned gentleman states that "This so-called 'Kerosene Shale' does not differ very widely from Cannel Coal and Torbanite. Like Cannel Coal, it usually appears to occur with ordinary coal in the form of lenticular deposits. Like Cannel Coal also, when of good quality, it burns readily without melting, and emits a luminous smoky flame, * * * * Unless it be decided to give the mineral a new name, it would be better to call it Torbanite, or Cannel Coal, rather than Kerosene Shale, since the oil which it yields is probably not Kerosene, and the substance itself is not strictly a shale, and, moreover, it is not very widely separated, either in physical properties or in chemical composition, from either Torbanite or the Cannel Coals."

For comparison the following analysis of Hydrocarbons from several well-known localities will be of interest. They are taken from Professor Liversidge's valuable work on the Minerals of New South Wales :—

Locality.	Moisture.	Volatile Hydro-Carbons.	Fixed Carbon.	Ash.	Sulphur.	Specific Gravity.	Analyst.
1. Hartley Vale, N.S.W.	...	82·50	6·50	11·0	...	...	B. Silliman.
2. Joadja Creek, N.S.W.	0·44	83·861	8·035	7·075	0·589	1·054	Liversidge.
3. Albertite, New Brunswick	...	57·490	42·086	0·424	...	1·105	„
4. Cannel, Scotland	...	69·77	10·45	19·78	...	...	Percy.
5. Cannel, Wigan	1·464	45·900	45·519	7·117	...	1·259	Liversidge.
6. Torbanite, Torbane Hill	...	71·17	7·65	21·18	...	1·170	How.

Mr. W. A. Dixon, F.I.C., gives the following result of an analysis of this substance, viz :—

Water	None
Volatile Hydrocarbons	50·86
Fixed Carbon	43·69
Ash	4·12
Sulphur	1·33
Total	100·00

In a communication to Mr. Bateman, this gentleman states—"Coal of this quality should be of value for gas-making, but it would be of little use for oil-making, as it would yield more tar than oils, which would be difficult to purify. I am satisfied, from its appearance and behaviour when subjected to heat, that it would give rather aromatic hydrocarbons (Benzene, Napthalis, &c.) than fatty ones (Olefines and Paraffin). It is not a Cannel (from which oils are not made) and not a shale, from which they are. Its colour, both in mass and powder and its fracture in mass, is different from either—and this difference is emphasized by the coke which it yields on rapid heating, neither Cannel or shale yielding a *true coke.* There seems to be something considerable extracted by chloroform, which is coloured brownish-yellow by the powder. I would be inclined to name the mineral Pitch Coal, as being most expressive of its appearance, and by its difference from highly bituminous coal as that of Stockton or Hetton mines, which I consider to be *resin coals.*"

50. CINNABAR (*Sulphide of Mercury*).

It is reported that this mineral was found many years ago in the Fingal District and also at Bagdad, and still more recently at Dundas, but no confirmation has occurred in either case.

51. CHRYSOLITE (*Silicate of Magnesia and Iron*).

Also known as Olivine. As a rule rocks containing this species are no good for the precious metallic minerals, and its occurrence may with some certainty be looked upon as an indication of their non-existence. Large specimens form the green stone termed Peridot, but those occurring here are usually too small to be of use to the jeweller. The crystals of this mineral are fairly common at several localities in Europe, but are very rarely found here or in Australia. Found in pale green semi-transparent particles in basalt, Dundas; in amygdaloidal basalt at Bischoff and the Wilmot River; in granite, Flinders Island (Gould); Upper Forth River, massive in basaltic dyke; of a yellowish-green colour in coarsely crystalline dolerite, Paddy's Sugar Loaf Mountain (W. R. Bell); near Hampshire Hills; Deloraine; as somewhat large crystals, often the third of an inch in diameter, which are of a bluish colour and opalescent tarnish, in partially decomposed basalt at the Emu River; commonly scattered as small blebs in black basalt, Table Cape; in large masses often intermixed with zeolitic matter, Sheffield.

52. CHIASTOLITE (*Silicate of Alumina*).

This is often classed as a variety of Andalusite, which is of the same composition. The common form has been obtained sparingly as knotted masses penetrating slate rock near its junction with the granite at Zeehan.

53. CHRYSOTILE (*Hydrated Silicate of Magnesia*).

Almost all of the locally termed Asbestus belong to this species, which usually occurs as seams and patches in Serpentine. Abundant near Beaconsfield and the Asbestus Range. The fibres are occasionally 10 to 12 inches in length, pale in colour, silky and beautifully soft to the touch. It is easily separable from the more compact rock. Samples occasionally occur that show a gradual transition to Hematite, with which it is closely associated; at the Heazlewood it abounds in the Serpentine, but is short in fibre, and amianthus-like; about Mt. Heemskirk it occurs whereever its parent rock exists, sometimes as short entangled masses of a white colour; in more or less quantity at Mt. Claude, Pieman River, Mt. Ramsay, the Penguin, Dundas, and it is said to occur east of the Mussel Roe River, N.E. Coast.

54. CHRYSOCOLLA (*Silicate of Copper*).

Usually occurs as a thin crust on other Copper minerals; colour various, shades of emerald green, passing to pale blue. Obtained as a thin coating in small patches.

Star of Peace Tin Mining Company, Cascade.

55. COPPER, NATIVE.

Is plentiful at several localities on the West Coast. At Mount Lyell and vicinity it is especially so, occurring in large and small arborescent masses, often reaching several pounds in weight. It is often found embedded in a clay or lithomargic magma, and sometimes attached to Limonite.

Many assays have been made which show it to be auriferous, occasionally to a high degree; at Mount Bischoff a beautiful highly polished foil of extreme tenuity has been obtained, coating the cleavage planes of the killas or altered slate near its junction with the Porphyry rock; at the Montagu and Duck Rivers Native Copper has been obtained in irregular small lumps embedded in a nearly black basaltic rock; it occurs in a vein of Garnet rock at the Hampshire Hills; with Baryta at the Wilmot River; as a flaky and frondose coating on Limonite and a silicious rock at Nolan's Creek, near the Pieman River; at Laurel Creek, a tributary of the Blyth River, it occurs in Chlorite, with Blende, Galena, and Copper Sulphate ; Dunyan Range ; Badger Plain ; near Circular Head; it is stated to also occur at Mainwaring Inlet, south of Macquarie Harbour.

Regarding the form that has been discovered at Mount Bischoff, this interesting and peculiar copper foil has been found under similar conditions in the elvan courses of Cornwall, England. Mr. A. K. Barnett states, in a paper entitled "Observations on the Elvan Courses, Greenstones, and Sandstones of Cornwall, with Remarks on their associated minerals" (Royal Cornwall Polytechnic Society, 1873), that "At Wheal Buller the joints of the elvan contain thin plates of Native Copper. Large quantities of Native Copper occurring in arborescent and filmy forms were found filling the joints of the elvan at the Consolidated Mines. It also occurs in the joints of the killas and the quartz veins associated with the elvan."

56. CROMFORDITE (*Chlorocarbonate of Lead*).

A single example obtained; the crystals are rectangular four-sided prisms, with the terminal edges replaced. It is very frangible, colourless, and white, with an adamantine lustre. It occurred as a small group attached to Galena with some associated Cerussite.

Adelaide Proprietary Mine, Dundas.

57. COVELLITE (*Blue Copper Sulphide*).

Obtained as an incrustation investing cupriferous Pyrites and as a bluish-black powdery deposit, filling cavities in a stanniferous lode.

Star of Peace Mine, Cascade; Ethel Mine, Blue Tier (Montgomery).

58. CUPRITE (*Red Oxide of Copper*).

In the vicinity of Mount Lyell this mineral occurs in some abundance in finely formed crystals which are, both as regards size and colouration, of the characteristic octahedron and its modifications. They are often attached or partially embedded in blocks of nodular Limonite; occasionally the cavities in the nodules are literally coated with the bright sparkling mineral, which, from its ruby colour, contrasts well with the brown iron oxide; the latter is often stained a shining black with Manganese Oxide and Stilphnosiderite.

59. CORUNDUM (*Oxide of Aluminium*).

The ordinary dull brown coloured form of this mineral is occasionally met with in the stanniferous drift of the north-east coast, but it gradually merges into its variety Sapphire, which is far more abundant than the typical form, although good clear gem-stones of the highly natural *Oriental* colouration are of exceptional occurrence. A limited number of very fine stones have been obtained which, after passing through the lapidary's hands, have been pronounced by good authorities to be gem stones of considerable value and quite equal to the average of those from Ceylon. They are usually very much waterworn, although occasionally specimens are met with that clearly show the rhombohedral crystallization. The *Oriental* Amethyst and Ruby are not known to occur in this island, but occasionally an *Oriental* Topaz has been obtained in Main Creek, near Thomas's Plains. The colour varies through all shades of blue, green, and purple, and from translucent to opaque. They are sometimes parti-coloured, showing various shades of blue and yellow to colourless. The highly-valued asteriated variety has been obtained, but it is of extreme rarity. A fine large example of the ordinary translucent Sapphire was obtained in the Weld River weighing 264 carats, but the colour was not of even shade or that so highly valued.

Mount Cameron; Thomas's Plains; Weld River; Main Creek; Moorina; Branxholm; occurs opaque, colourless to dirty blue and grey, Blyth River; in clear blue fragments at the Boat Harbour, near Table Cape.

The Sapphire has not been discovered *in situ*, although its matrix will in all probability be found to be Granite.

60. COPIAPITE (*Yellow Sulphate of Iron*).

Occurs in small quantity, resulting from the decomposition of Melanterite, in one of the adit levels at Mt. Bischoff. This mineral is often observed on Melanterite as a thin incrusting powder; it is probably a transmutation of that species by loss of water. Some pyrites from Bischoff decompose directly to this mineral—this peculiarity is especially noticeable in cabinet specimens, which after a time are often literally transformed into the mineral. This pyrite is found in a lode composed of Sphalerite, Fluor-Spar, and Steatite, east of the great mine.

61. CHABAZITE (*Hydrated Silicate of Alumina, &c.*)

An abundant zeolite, which occurs in the cavities of amygdaloidal Basalts. The obtuse rhombohedral crystals are usually well formed, clear, and colourless. Abundant near the railway bridge that crosses the Hellyer River; of small size but well formed groupings, Springfield; associated with other zeolitic minerals, Olivine, and Calcite, Sheffield and near Mt. Claude; with ferro-calcite, Lefroy; occurs abundantly in vesicular basalt at Mt. Pelion and vicinity,—the crystals are well developed and in fine groupings, often lining the cavities. Rounded waterworn nodules of the black basalt are often met with in the streams which clearly show the implanted crystal groups, and are sometimes mixed with other species of zoelitic minerals and ferro-calcite.

62. CHROMITE (*Oxides of Chromium and Iron*).

This mineral is apparently widely distributed throughout the north-western portion of the island, but has not been recorded as occurring in large quantity. It is always to be found in more or less profusion wherever Serpentine occurs, sometimes intermixed with that rock in the form of minute crystals, but more often as irregular patches of various sizes, which occasionally form somewhat extensive masses.

In the Heazlewood River and its vicinity minute, intensely black polished octohedral crystals are plentiful. In favourable places in the beds of some of the smaller streams it is quite possible to obtain several ounces weight of these crystals in a dish of wash-dirt. At this locality it is also fairly abundant in the massive form; in crystallized masses, in a small vein occurring between Serpentine and Quartz, near the River Forth (J. Smith); Pieman River; Meredith Range; Dundas; Asbestus Mountain; very abundant as small crystals in Harman's Rivulet, Huskisson River, and at other places.

63. CHLORITE (*Hydrated Silicate of Alumina and Magnesia*).

Occasionally abundant in stanniferous lodes at Ben Lomond and Heemskirk; at Bell Mount, west of Mt. Claude, with Sphalerite; as Chlorite Schist it is abundant between Waratah and the West Coast. The substance occurring at Bischoff that is usually termed Chlorite is a greenish tourmaline rock which is peculiar to that locality.

A fibrous radiating variety occurs at Mt. Ramsay and Hampshire, the former of a pale green and easily decomposable, the latter of a darker colour more durable in nature. At the Laurel Creek, near Mount Housetop, the mineral occurs as a vein in a mineralised dyke; it is of various colours and much stained with Iron Oxide. At the Prince George Mine at Heemskirk in sheaf-like aggregations, which cross each other; and sometimes radiating; at the Hampshire Hills as Chloritic Porphyry, in two dyke masses running almost parallel, which are traceable for a considerable distance. On the north-eastern tin field this mineral is distributed, but usually in small quantity; it occurs as a constituent of Protogene, a stanniferous rock, at Ben Lomond and Gould's Country.

64. CIMOLITE (*Hydrous Silicate of Alumina*).

Occurs as a deposit near St. Leonards, and is often termed locally Meerschaum. It is of a smooth compact texture, with a dead white colour and subconchoidal fracture.

65. CALCITE (*Carbonate of Calcium*).

The massive form or limestone occurs abundantly at Bridgewater; Maria Island; Mersey River; Mackintosh River; Gordon River; Don; Heazlewood; Beaconsfield; and other places.

As Travertine, at Geilston; as Roestone, on the west side of the Savage River; as Iceland Spar, near St. Mary's and near Deloraine; abundant, stalactitic, at Chudleigh and near Frankford; in more or less perfectly crystallized bunches and bands in lode-matter at Heazlewood, Zeehan, and Dundas; in vughs and imbedded in basalt rock, Bischoff and Lefroy; of a pink colour with carbonaceous matter, Swansea; as small blue-coloured crystals, Madam Melba Mine, Dundas; flesh-coloured in Syenite Porphyry composed of Orthoclase, Hornblende, and Quartz in a felspathic magma. (Ballarat School of Mines Museum.)

66. COBALTINE (*Arsenide of Cobalt and Iron*).

Occurs in masses with cupriferous pyrites, galena, and grey copper, Penguin Silver Mine, Penguin River. (James Smith.)

67. CASSITERITE (*Oxide of Tin*).

As is well known, this is the only commercial ore of Tin. It crystallizes in the pyramidal system; in habit it affects short four-faced prisms with complex terminations; it often occurs mackled, and is, when freshly broken out, of adamantine lustre. As a distinguishing character the streak or powder is always pale-brown or greyish white. In colour this mineral varies in a great degree; it occurs commonly black and in various shades of brown, but is often almost colourless, red, yellow—pale and dark, white, grey, and sometimes variegated. In structure it may be compact, fibrous, nodular, radiated, or crystalline. According to colour or structure its varied forms are termed by miners black tin, resin, amber, ruby, wood, shot-holed, blistered mahogany, and other local appellations. Alluvial tin is generally much water-worn or rolled, but in many cases the crystals are but little abraded; it is usually opaque, but is occasionally translucent to almost clear transparent. It is well known to metallurgists that stream or alluvial tin—as with gold—is richer than that derived from its matrix or lodes; the reason for this, some mineralogists suppose, is that the alluvial mineral has a kind of growth by continuous coatings received from the metal held in solution; but it appears to me more reasonable to suppose that this peculiar feature is caused by the outer crust being abraded, leaving a richer central portion or nucleus. Cassiterite occurs in either the eruptive granite rock itself or in the immediate neighbourhood. The rock itself is, as a rule, comparatively poor in Felspar and shows a corresponding increase in the important mineral Mica, which invariably contains more or less Lithia as a constituent, so that the presence of this element may be looked upon as a fair indication of the existence of Tin Oxide. The mineral is frequently impregnated in the rock itself, in which case it is of primary origin. As occurring in lodes or veins of secondary character it is usually much more permanent, and may then be expected to exist in depth. This island is one of the most important tin-producing countries of the world, and a peculiar interest is attached to its discovery, as it was apparently one of the first minerals found in Australasia of which we have any record. Professor Liversidge states ("Minerals of New South Wales," page 77), "The probable presence of tin in Australia was mentioned as early as January, 1799. Collins, in his account of the English colony of New South Wales, states that Mr. Bass, the surgeon of *H.M.S. Reliance*, found on the beach of Preservation Island (on the north coast of Tasmania, near the south coast of Barren Island) a very considerable quantity of the black metallic particles which appear in the granite as black shining specks, and are in all probability grains of tin." The next record that I have met with occurs in the Proceedings of this Society for the year 1854, page 425-431, in which reference is made to samples in the museum of a Mr. Thomas Winsmore Wilson, of Barnsley, Yorkshire, England. In this paper the following remarks occur: "No. 25, Tinstone—as regards this Tinstone I need not remind you of its value. If you could open a mine as rich in Tin as this specimen you would be very fortunate in the mining department." This sample was obtained "on elevated land below the Tier, St. Paul's Plains." The wonderfully rich deposit of tin at Mount Bischoff was discovered by Mr. James Smith in 1871, and soon after that year many other payable finds occurred, principally in the north-eastern portion of the island. It is now known to occur, both as drift and lode, at many places throughout the northern portions, several of the eastern islands in Bass Straits, and it has been recently discovered at one locality near the extreme southern coast.

It may be enough, from a mineralogical standpoint, to state that almost all of the many recorded varieties of this important mineral have been found more or less abundantly at one or other of our tin-producing districts. The ordinary "Black Tin" predominates, but the coloured varieties are by no means rare at special localities. The "Ruby Tin" varies from pale red to a ruby tint, and is often quite pellucid; it is fairly abundant in the drift at Branxhom, Moorina, and Weldborough. The "Resin Tin" is usually dull, waxy, and opaque, and of a yellow to pale brown in colour. It occurs at several of the mines in Gould's Country and at Moorina; both of these kinds are of exceptional occurrence in the lode matrix, but the first has recently been discovered in the Ben Lomond District.

The coloured forms are as a rule confined to the produce of the north-eastern tin fields, that from the north-western portion being the ordinary Black Tin of commerce. At the South Pieman

River a massive variety occurs which is known as "White Tin;" it is an amorphous compact ore of a dull white to pale brown colour. At Mount Ramsay a peculiar variety has been obtained sparingly intermixed with the normal kind; it is a small angulated form of a brown colour and highly polished, generally but little waterworn. That from Constable's Creek is of a rich brown colour, with striations of various shades in fine crystallized masses of considerable size embedded in a quartz gangue. The highly polished crystals and mackles from the Blue Tier and vicinity are exceptionally fine, and samples from some of the mines in the Ben Lomond district are remarkable for the same reason.

The ore from the Iris River, near the Middlesex Plain, is, as a rule, a very minute black to dark brown polished form, which often occurs dispersed throughout a white kaolinic clay or decomposed felspar. The Bischoff Tin is dark brown to black; the major portion of that obtained is found in small granular particles, but very large masses of almost pure Cassiterite have been obtained mainly composed of solid aggregations of crystals. At this locality this mineral has been obtained intimately associated and scattered throughout various forms of Pyrites, mainly arsenical, and it is reasonable to suppose that the greater portion of the lode mass or "Bonanza" that has been worked had its origin from a huge mass of Pyrites afterwards transmuted to Limonite, and now forms the well-known Brown Face of the mine. The recent discovery of Native Sulphur associated with a mass of fine quartz Sinter or Geyserite, showing a close resemblance to samples from the Hot Springs of New Zealand, may as investigation proceeds throw some light upon the important subject of its origin. The principal rock formation at Mount Bischoff is Quartz-porphyry—often containing small crystals of Pycnite—with shoots of the Topaz-porphyry, but tin is often found in the clefts of the adjacent killas or metamorphic slate. At north-east Dundas Cassitterite is also reported to occur, mixed with various forms of pyrites, in some respects resembling the Bischoff formation.

It is said that Resin and Ruby tin occur at the base of the Norfolk Range, north of the Pieman River, and that the general character of the tin-bearing drift much resembles that of the north-eastern fields, but this requires confirmation.

The principal stanniferous rocks of this island are Granite, Quartz and other Porphyry, Greissen, and Protogine. Quartz is not an unusual lode gangue, and kaolinic clay and Limonite form secondary matrices. The principal associated minerals are Wolfram, Pyrites of various kinds, Molybdenite, Tourmaline, and more rarely Fluor-spar, Chlorite, and Bismuth.

The stanniferous drift is mainly composed of fragments and crystals of quartz and other rock *débris*, that of the North-east coast containing numerous water-worn Sapphires, Zircon, Pleonaste, Menaccanite, and rarely Gold, Beryl, and silicified wood. The drift on the West coast is mainly quartz of various varieties with fragments of wood transmuted to Marcasite—which on exposure soon decomposes to the sulphate.

The principal localities of the mineral are, on the North West—Mt. Bischoff; Mt. Hicks; Meredith Range; Mt. Ramsay; Mt. Housetop; Blyth River; North Pieman; near Mt. Claude; Iris River, near Middlesex; Granite Tor; Ring River; North Dundas. On the North-east—Mt. Cameron; Moorina; Branxholm; Mt. Stronach; Mt. Maurice; Weldborough; Blue Tier; St. Helen's; South Freycinet Peninsula; Weld River; Mussel Roe River; Cascade; Derby; Mt. Horror; St. Paul's; Ben Lomond. In Bass Straits—Flinders, Clarke, and Cape Barren Islands. In the South—Cox's Bight, near Port Davey.

The economic results of our tin-mining industry have been highly satisfactory; for although practical operations were not commenced until the year 1873, and lode-mining, with the exception of the celebrated Bischoff, has been comparatively neglected, it has now become our principal mineral product.

Tin first appeared as a factor in our mining industry in 1873, in which year the total export amounted to four tons of ore valued at £220. From that period to the end of 1892 the export of the crude and smelted metal represented not less than 62,130 tons, valued at £5,599,467.

The following statistics may be interesting as showing the quantity and value of the tin exported during the past ten years:—

Decennial Return of the Tin Mining Industry.

Year.	Ore.	Metal.	Value.
			£
1883	77	4045	376,446
1884	32	3675	301,423
1885	—	4242	357,587
1886	—	3776	363,364
1887	1	3606	407,857
1888	2	3775	426,326
1889	31	3764	344,941
1890	4	3214	296,761
1891	56	3235	293,022
1892	—	4971	298,260

(The Returns as above quoted are taken from the Tasmanian Official Record, 1892, with additional information supplied by the Mines Department.)

68. CERARGYRITE (*Chloride of Silver*).

The well-known Silver Chloride has been obtained in limited quantity at the Dundas, Zeehan, Heazlewood, and at the

Scamander River Silver-fields. It usually occurs as minute irregular blebs and crystals in ferro-manganese gossan and in kaolin with other oxidised metallic minerals.

69. CHLOROPHANE (*A variety of Fluorite*).

When heated this mineral shows the peculiar phosphorescent light of a clear emerald-green colour. It usually occurs from light violet to colourless, but is very rarely, if ever, obtained in a crystallized form, being generally in compact to granular masses. Mt. Bischoff; Mt. Ramsay; Branxholm; Ben Lomond (Great Republic Tin Mine).

70. CERVANTITE (*Antimony Oxide*).

Abundant as a result of the decomposition of Antimonial Minerals, usually as a thin coating on Jamiesonite, Galena, and and on lode-matter, but occasionally massive. Madam Melba, Comet, Mastrie's Broken Hill mines at Dundas are prominent localities; it also occurs in less profusion at several of the silver-lead mines in the Heazlewood District and at Zeehan. Occurs in small quantity in a quartz reef known as Ragged Jack, about nine miles east of Deddington; Pyrites, Galena, and Stibnite are found with it as accessory minerals.

71. COLLYRITE (?) (*Hydrated Silicate of Alumina*).

A substance fairly answering the general characters of this mineral occurs in bands and patches in the cavities and fractures of the Diabase rock at Launceston.

72. CHALCOCITE (*Copper Sulphide*).

So far I have not met with specimens of this mineral, although reported to occur at Mt. Maurice, Mt. Ramsay, and Badger Head.

73. CALAMINE (*Carbonate of Zinc*).

Occurs in small quantity at Heazlewood and Zeehan; several localities are given in the Pro. Royal Soc. Tas. for 1854, but the identification is very doubtful; is reported to occur at Mt. Bischoff.

74. CROCOISITE (*Chromate of Lead*).

A well known beautiful mineral, generally supposed to be peculiar to the silver-lead mines in Siberia.

Its first discovery in this island was made a few years back by Messrs. Smith and Bell at the Heazlewood Silver-Lead mine. It there occurs of its characteristic bright, shining, hyacinth-red colour, in somewhat small, thin, aciculine bunches penetrating and often coating a soft ferruginous-clay gossan, commonly with minute crystals of Cerussite and Pyromorphite. At the Whyte River mine it was found plentifully in the country rock, a soft decomposed Diorite, abutting on to the lode, coating the faces of fractures and cleavage planes. In some instances flakes of the mineral several inches in diameter were detached. Rarely patches of small monoclinic crystals occurred, but this was exceptional.

In vughs, occurring in the capping of the lode or the adjacent country rock, they were often found to be thickly coated with bunches of the mineral, of bright colouration and of great beauty.

At the Adelaide Proprietary mine, at Dundas, this species is very plentiful. It commonly occurs in large columnar prisms, often several inches in length, that penetrate the vesicular ferro-manganese gossan that overcaps the lode. In the workings of this mine some extremely fine and beautiful specimens have been obtained, the mineral often coating white Dundasite, and ocasionally associated with crystals and large bunches of Cerussite and more rarely Anglesite. In some samples the red prisms penetrate the gossan intermixed with botryoidal Psilomelane and occasionally patches of Galena occur in the more solid portions; occurs on Embolite, Hay's Prospecting Association, Heazlewood.

Crocoisite has not been discovered in Australia. So far as examined this mineral has not been found to be argentiferous.

75. CERUSSITE (*Lead Carbonate*).

Occurs in more or less quantity wherever the primary lead sulphide exists. The Silver Queen, Sylvester, and Austral mines at Zeehan, the Maestries Broken Hill, Comet, and Adelaide Proprietary at Dundas, with the Godkin and Whyte River mines in the Heazlewood, district have afforded fine examples in massive amorphous, subcrystalline and well developed orthorhombic crystallizations.

Occasionally it is permeated to some extent with one or other of the Silver Chloride group, when it assumes a grey-coloured amorphous form, which is locally known as "grey ore." In this state it invariably gives high assay returns for Silver. It often occurs stained and encrusted with both green and blue Copper Carbonates, and in some instances found coated with a mixture of Antimony and Lead Oxides. Anglesite is a species closely resembling this mineral, and it is often intimately associated with it, but a simple qualitative analysis soon detects the different composition, its habit of crystallization is another distinguishing character—Cerussite occurs in tabular forms, usually six-sided prisms with various terminations, and is often macled.

76. CYANOSITE (*Sulphate of Copper*).

Originates from the decomposition of Cupriferous Sulphides; generally occurs stalactitic, or as an amorphous efflorescence in old mine workings. Colour, various shades of blue to bluish-green. From adit, North Valley, Mount Bischoff; Gad's Hill Range, Upper Mersey River, after a brass-yellow variety of Chalcopyrite, it is often intermixed with blebs of Galena and Blende.

77. COAL.

River Don; Mersey; Port Arthur; Seymour; Schouten Island; South Cape; near Waterhouse; Three Hut Point; New Town; York Plains; Jerusalem; Cullenswood; Mount Nicholas; Sandfly; Adventure Bay; Port Cygnet; Hamilton; Richmond; Prosser's River; Spring Bay; Mt. Munro; Fingal; Longford; Jericho; Inglis River; Mersey River; Western Bluff; Gad's Hill; Magnet Range.

Full detailed descriptions of our Coal measures, with numerous analyses of samples, will be found in the Proceedings of the Royal Society ot Tasmania, 1851, Johnston's Geology of Tasmania, 1888, and in the Tasmanian Official Record, 1892.

78. DOLOMITE (*Carbonate of Magnesia and Lime*).

The pure crystallized form is of exceptional rarity, but the ordinary massive kind is of common occurrence, and is sometimes met with in considerable quantity. The gangue of the silver-lead lodes of the Heazlewood and Dundas districts is often composed of an irregular mixture of Brown-spar, Siderite, Calcite, with a limited quantity of quartz most of which is more or less stained with the oxides of Chrome and Nickel. At Dundas a blue-coloured variety has been obtained associated with Galena.

The massive form occurs at Mount Claude, near Mount Pelion, Heazlewood, and Dundas.

79. DIAMOND (*Pure Carbon*).

The occurrence of the Diamond in this island is extremely doubtful. It has been reported that a single minute specimen was detected in a parcel of gem-sand that was obtained in the vicinity of the Hellyer River, and sent to England for examination by the Van Diemen's Land Company many years ago.

80. DIALOGITE (*Carbonate of Manganese*).

See RHODOCHROSITE.

81. DUFRENOSITE (*Sulph-arsenide of Lead with Copper and Silver*).

Usual colour steel-grey, with a reddish-brown streak and metallic appearance. It is said to occur intermixed with Tetrahedrite and Cupriferous Pyrites at the Fahl Ore mine, Dundas.

82. DUNDASITE (*Hydrous Carbono-phosphate of Lead and Alumina*).

This apparently new mineral compound forms an incrustation on ferro-manganese gossan. It is composed of small spherical aggregates, usually closely matted together. Under the lens these bunches show an extremely fine radiating structure. The colour internally is silky milk-white with a velvety outer crust of a dusty yellow-brown, The surface often has numerous adherent crystals of Crocoisite which not rarely penetrate the mass. These crystals are always minute, but remarkable for their extremely fine development and acute angles.

The qualitative reactions of this new substance are as follows :—In the matrass it becomes yellow and yields water. It is infusible before the blowpipe, but on coal, with fluxes, yields a considerable quantity of metallic lead, and coats the surface with the characteristic yellow sublimate. When moistened with sulphuric acid it gives distinct reaction for phosphoric acid. In nitric acid it dissolves with strong effervescence; the residuum from the solution strongly deflagrates and gives phosphoric reaction. The powdered material, when moistened with cobalt nitrate, clearly shows the beautiful blue colouration of alumina. With limewater gives the turbidity of carbonic acid. Hardness about 2.

Adelaide Proprietary mine, Dundas.

83. EPIDOTE (*Silicate of Iron and Calcium*).

This species frequently occurs in richly metalliferous rocks, and in a lesser degree it is widely diffused. It is usually of a peculiar and characteristic pistachio-green colour, but it often affects a reddish-brown colour when occurring in Serpentine. Common in greenstone, west of the River Leven and other places (J. Smith); abundant in clefts of rock, Magnet Range; near Table Cape; about the Forth River; vicinity of Bischoff; with quartz as veins in the greenstone, usually occurs in bunches of crystals—some of the individual specimens often met with up to an inch in length, Dunyan Range, Duck River; Woolnough, of clear colouration but small size; at Port Cygnet a black variety has been obtained in long bladed, thin, semi-crystallized bunches, which are fairly abundant in a felspathic porphyry; at the Whyte River it has been found in the clefts of lode material with bunches of Calcite and Pyrites; at Dundas it is fairly abundant in quartz.

84. EVANSITE (*Hydrated Phosphate of Alumina*).

A rare species, occurring as botryoidal incrustations, which are often almost colourless, but sometimes milky white, at all times having an attractive pearly lustre. It appears to differ from the typical form in having a proportion of Silica chemically combined. The examples were obtained in a silver-lead lode with Galena and Sphalerite.

Zeehan.

85. EPSOMITE (*Sulphate of Magnesia*).

Found as sub-crystallized aggregated and delicately fibrous masses, but also commonly as a more or less compact incrustation. It occurs in caverns and fissures. Abundant in the neighbourhood of the Dromedary Mountain; about the Upper Lake River, near the Western Tier; at Exton; Alum Cliff Caverns, near Chudleigh.

86. ERYTHRITE (*Arsenate of Cobalt*).

This mineral may be at once known by its characteristic peach-blossom colour. An extremely small quantity has been obtained intermixed with earthy ferruginous gossan at the Penguin Silver-lead Mine, Penguin River; in small patches of distinct colouration as a coating on lode gangue, probably derived from the transmutation of an arsenide, at the Hampshire Silver Mine, Hampshire Hills (W. R. Bell).

87. ENSTATITE (*Silicate of Magnesia and Iron*).

This species is apparently synonymous with Bronzite. Occurs in sub-crystalline masses of considerable extent in connection with Serpentine at the Heazlewood with its variety Schiller Spar, and other allied forms of almost similar chemical composition; abundant with its varieties, Huskisson River; Parson's Hood; Magnet Range.

88. EUCLASE (*Silicate of Alumina and Glucina*).

Two well preserved crystals from the stanniferous drift at Moorina agree with the general characteristics of this rare mineral.

89. EMBOLITE (*Chlorobromide of Silver*).

Found in limited quantity, but often quite pure. As is usually the case the crystals are difficult to obtain well-defined, but moderately good specimens are not rare. Occurs intermixed with ferro-manganese gossan and earthy-lode matter. The more important localities are the following mines:—Central Dundas, Maestrie's Broken Hill, and Dundas Proprietary, at Dundas; The Queen, Sylvester, and Junction, at Zeehan; and the Godkin, Washington Hay, and Whyte River, in the Heazlewood District. Embolite merges gradually into Cerargyrite, the two species being isomorphous. The mixtures occur both here and in Australia in varied proportions, so that the one species may gradually merge into the other.

90. EULYTINE (*Silicate of Bismuth*),

A very rare mineral, occurring in minute globular patches of a yellow to brown colour, with a resinous lustre.

Hampshire Silver Mine (W. R. Bell.)

91. FAHLUNITE (*Hydro-mica*).

Several forms of the hydro-mica group occur at the Mt. Bischoff, the Hampshire Hills, and elsewhere. The identification of the species is at the best doubtful in almost all the members of this very unsatisfactory group. The Bischoff samples are soft, compact, and grey in colour; that from the Hampshire is much darker, almost black in colour, with the surface shining.

92. FLUORITE (*Fluoride of Calcium—Fluor-spar*).

Some very fine masses of this mineral have been obtained at the Great Republic and other tin mines situated at Ben Lomond. The crystals are usually small, but beautifully defined: a common form is pale purple to almost colourless, with the apices of the acute angles distinctly stained an intensely dark purple. Modifications of form and macles are not uncommon at this locality. Much of the Fluor-spar occurring in this island belongs to the variety Chlorophane, which see.

93. FRANKLINITE (*Oxides of Iron, Manganese, and Zinc*).

A mineral with metallic lustre, dark, almost black colour, and characteristic reddish-brown streak. Obtained in amorphous and crystalline bunches intermixed with galena, mainly at the 200 feet level, Silver Queen Mine, Zeehan.

94. GARNET (*Silicate of various bases*).

Undetermined species occur at the Hampshire Hills, where they are found in profusion. They vary from brown to black in colour, and often reach an inch in diameter. On the south side of Cape Barren Island they exist *in situ* in a quartz porphyry, also free in the detritus derived therefrom usually mixed with Cassiterite; at several localities in the north-eastern tin fields they are plentiful in the drift, but generally of small size; common in the vicinity of Mt. Heemskirk, usually opaque, but sometimes of good colour and transparent; near Mt. Claude a solid compact to subcrystalline garnet rock of yellowish-brown colour occurs apparently belonging to the sub-species Grossularite; at Mt. Ramsay another rock mass has been found of a dark brown colour; at this locality well formed crystals have been obtained imbedded in a soft magma that allows them to be easily extracted; near Highwood, on the Emu River, clearly cut dodecahedrons of a translucent white to light yellow colour occur in lode-matter (W. R. Bell); on the Whyte River, near the Meredith Range, in minute crystals and compact masses of reddish-yellow colour—apparently belonging to the variety Essonite—with Actinolite and Molybdenite as accessory minerals.

95. GOSLARITE (*Zinc Vitriol*).

Occurs as small stalactitic and investing bunches, which are usually much stained with iron.

Obtained in an adit, intermixed with other sulphates. Blue Tier, near Beaconsfield.

96. GRAPHITE (*Impure Carbon*).

Of common occurrence, but invariably of indifferent quality and usually in the form of graphitic slate.

It is often met with in the silver-lead lodes of Zeehan and Dundas, where it is usually found on fissure lode walls more or less intermixed with earthy matter and on the cleavage faces of Galena; Norfolk Plains (Pro. Royal Soc., Tas. 1851), near Mangana; Mt. Heemskirk, in the cleavages of the granite rock; Beaconsfield; Anderson's Creek; North Valley at Bischoff, as a large mass with a high metallic lustre; on the beach about two miles west of the Leven River; as thick coatings in the joints of a crystalline limestone on the Wilmot River; reported as occurring in considerable quantity at Barren Island.

97. GROSSULARITE (*a variety of Garnet*).

Occurs as a subcrystallized to somewhat solid rock near Mount Claude. The colour is pale olive-green to brown, with a rather vitreous lustre.

98. GREENOCKITE (*Sulphide of Cadmium*).

This has been reported to occur at the Godkin mine, Heazlewood, implanted upon Sphalerite and lode-matter. (A. R. Browne).

99. GÖETHITE (*Hydrated Peroxide of Iron*).

A good mineral species, crystallizing in the rhombic system. It may be known from other iron minerals by its blood-red colour when seen by transmitted light, and brownish yellow-streak. It is commonly globular and stalactitic, rarely in crystallized masses.

Dial Range; Blythe River; Penguin; Dundas; Pieman River; Emu Bay.

100. GALENITE (*Sulphide of Lead*).

This mineral, the most abundant ore of Lead, is widely distributed over the northern and western portions of the island, occurring in all its many variations of structure, from the steel-grain to the coarse cubical ore, often showing extreme variations in this respect in the same district or even individual mines. In geological occurrence it also varies to a greater extent than almost any other mineral species; here it is common to the tin-bearing granites of the Ben Lomond and the fossiliferous Silurian slates of the Zeehan districts.

From all localities our Lead Sulphide is characterised by the unusually large assay returns of Silver that it yields, so that it is reasonable to anticipate that it will become one of our most important economic minerals. The true crystals are exceptionally rare, and the few that have been obtained are small and obscure. This mineral often contains a considerable admixture of Antimony, in which case it is proportionally more or less striated in structure; some samples from the Heazlewood district show this in a marked degree. As a rule it is comparatively pure and free from deleterious admixture, zinc in particular—the bane of the metallurgist—being of exceptional occurrence in large quantity. Many specimens from the Junction and Queen mines at Zeehan are highly iridescent and show a beautiful play of colouration in blue, green, and red.

At the Sylvester mine a large quantity of beautiful dark green Pyromorphite and fairly well crystallized Cerussite has been obtained, overcapping the primary ore; and one of the lodes on the Queen property contained a considerable amount of Lithomarge, more or less impregnated with Silver chlorides, in the surface levels. That from the Owen Meredith mine had in many instances very fine masses of arborescent Native Silver in the clefts of the ore body, with which an Antimonial Silver mineral was also associated.

At the Maestrie's Broken Hill mine at Dundas an extensive body of oxidised argentiferous lead ore has been worked, overcapping and interspersed throughout the original mineral. The ferro-manganese lode capping of the Adelaide Proprietary mine at the same locality has become somewhat celebrated for the wonderfully fine bunches and masses of Crocoicite that have been obtained; in some of the more solid portions of the surface outcrop the gradual transmutation of the Lead Sulphide to the Chromate can be distinctly traced, and the vughs often contain remarkably developed crystals of the latter as a coating. The Scamander Silver-lead mine consists of a mixture of several silver-bearing minerals, the more important of which are Pyrites—principally arsenical, Sphalerite, and Galena. At the Rex Hill mine in the Ben Lomond district the somewhat peculiar association of Cassiterite, Mariatite, Chalcopyrite, and Galena is a noticeable feature in a portion of the property. In addition to the minerals mentioned, small lumps of green Malachite are occasionally met with in trenches on the surface. At the Madame Melba at Dundas, and Silver Cliff at Bischoff, Galenite is commonly met with in conjunction with Jamiesonite and mixed oxides, resulting from the decomposition of the two minerals.

On the south bank of the Mackintosh River, about forty miles south-east of Bischoff, a large body of Galena has been discovered, much of which is intermixed with a cleavable Calcite and amorphous Siderite. It occurs near Deloraine with Baryta and Dolomite, sometimes showing alternate bands of Galena and Sphalerite. In the gold mining districts of Beaconsfield, Lefroy, and Mathinna, it is found in the reefs, often to considerable depth, in limited quantity, generally intermixed with Pyrites. At the Hampshire Hills an argentiferous lode was worked upon by the Van Diemen's Land Company some years back, but without any permanent practical results. The matrix of this discovery was a hard siliceous rock, differing in many respects from any other hitherto found. Its mineral constituents also varied in a most remarkable degree, and included several species which are, so far as known, peculiar to itself. These consisted of Apatite, Strontianite, Fluor-spar, Argentite, and Pyrites, with several minerals of Cobalt and Bismuth. Scattered throughout this interesting and diverse mixture are blebs and bunches of argentiferous Galena. In the Penguin River Silver mine the ore mass mainly consisted of a mixture of Pyrites, Sphalerite, with Galena, and a small quantity of Nickel and Cobalt bearing minerals; the mass giving very satisfactory assay returns.

At the Whyte River, and at some of the Dundas mines, a singular mixture occurs, which is composed of Galena and Cerussite, forming a sulpho-carbonate. The two minerals are so closely combined that the reactions for both forms are obtained by qualitative analysis.

The characteristic gangue or lode matrix of our Silver-lead mines is commonly, if not generally, a compact form of Siderite or Carbonate of Iron, which is occasionally varied by an admixture of quartz in much less quantity, and earthy matter. The Old World matrices of Calc-spar, Fluor, and Baryta are strangely the exception, and in fact are almost unknown on the more important Silver-lead fields of the West Coast. Many of the other mineral species that are usually found associated with Galenite in the metalliferous regions in other parts of the world are, as a rule, found with it here, with the exception that some of the more common ores of Zinc elsewhere are of much less frequent occurrence, and the few that have been discovered are in far less abundance than is usual in the mines of Europe and America.

The earliest recorded discovery of Galenite in this island was apparently that of an unimportant nature made at Norfolk Plains in 1851 (Proceedings Royal Society Tasmania, 1851), and it was many years after that practical mining for Silver-lead commenced. The first was that at the Scamander River in 1885. Assays from the mixed argentiferous minerals obtained in the mine at this locality gave variable returns up to as high as 200 ozs. of Silver per ton, and a bulk test of about 50 tons produced at the rate of 32 ozs. to the ton with a fair proportion of lead. This mine is now shut down and the locality is practically abandoned, notwithstanding that several discoveries of argentiferous Galena have been made in the vicinity.

The more important discovery of the existence of Galenite at Mount Zeehan on the West Coast was made by Frank Long on the 8th December, 1882, (Tilley, "The Wild West of Tasmania," 1891), but mining for this mineral did not commence until about five years later.

The principal localities are:—Zeehan; Dundas; Ben Lomond; Scamander River; Bischoff; Mount Claude; Dove River;

Heazlewood; Mount Lyell; Castray River; Mount Pelion; Penguin; Forth; Henty River; Lake Dora; Constable's Creek; Dial Range; Arthur and Mackintosh Rivers.

The "Statistics of the Colony of Tasmania" for the year 1891, give a "Return showing, as far as can be ascertained, the value of Minerals produced to date, 31st December, 1891," in which the Silver-lead mining industry is credited with the sum of £91,653: no Silver returns being available prior to 1888. By far the greater portion was produced from Sulphide ore or Galena.

The yearly Return from the same authority is as follows:—

Silver (Argentiferous Lead).	1888.	1889.	1890.	1891.
Quantity of ore raised Tons	417	415	2053	4810
Value of Products. £	5838	7044	26,487	52,284

The following has been kindly supplied by F. Belstead, Esq., Secretary of Mines:—

Return showing the Quantity and Value of Silver producea in Tasmania during 1892.

Mineral.	Quantity.	Value of Silver. £ s. d.
Silver-Lead Ore...	4019 tons (yield of Silver about 140,665 ozs.)........................	22,858 1 3
Bullion	613 tons (yield of Silver about 36,780 ozs.)	5976 15 0

Mr. Belstead states, *in literis,* that "it is impossible to obtain even an approximate estimate of the Lead." It may be fairly estimated that the total value of the Silver-lead ore raised during the past year was not less than £60,000.

101. GOLD.

The early history of Gold discovery in this island is extremely vague, but it appears to have been found about the year 1850 in the Fingal District, although systematic mining for the metal did not commence for some time after.

The auriferous districts, so far as discovered, are fairly well understood, so that from a mineralogical point of view it would be superfluous to minutely enumerate them. A few peculiar features as to the paragenesis and other local peculiarities may be of passing interest and worthy of record. At the Campbell's Reward Mine, near Mt. Claude, the precious metal occurred in a very small vein or fracture plane in a rock that has been termed Porpyritic Syenite; the Gold was faced on to the rock with a backing of decomposed Felspar, and occurred in fern-like arborescent patches occasionally altering to radiating masses, the whole presenting a very peculiar and unique appearance. Much of the separated metal had the appearance of irregularly chopped hair, each fragment as seen under the microscope being covered with extremely minute recurved barbs; scattered throughout the mass were also flaky plates of extreme tenuity, the surface of these being covered with sub-crystalline impressions. Altogether the general structure of the metal and its mode of occurrence differ very much from any other auriferous formation known to exist in the island; the Long Plain alluvial gold-field was noted for the numerous and remarkably fine crystal forms of the metal that were obtained—even rivalling Ballarat in this respect. Many individual crystals were found measuring above ¼-inch in length, which were often aggregated together in masses of considerable size; some presenting an exquisitely beautiful arboriform structure and others again in a filiform mass, the latter occasionally so intermixed as to present a sponge-like structure. It is to be regretted that more examples of these peculiar masses were not secured as museum specimens, for now their occurrence has almost become a matter of history. The gold was, as a rule, but little waterworn, and apparently occurred in small lenticular veins composed of Siderite, Quartz, and Pyrites, interlaminated in the folia of the schistose country rock. In some of the Lefroy mines very fine examples of "slickensides" occur, which are often faced with striations and patches of gold, the whole being furrowed and highly polished; at the Queen River an almost white gold has been obtained, caused by its admixture with silver, and thus forming the variety known as Electrum; at M'Kusick's Creek, near the King River, a considerable number of crystals were obtained, the prevailing form being much elongated, in many instances reaching nearly an inch in length; on the property of the Union Prospecting Association, at Back Creek, the metal has been discovered scattered throughout a matrix of white friable sandstone, which apparently forms the wall of a quartz reef; at Mt. Ramsay the cupriferous pyrites, occurring in the characteristic hornblendic rock of the locality, has been found by analysis to be highly auriferous; at Mt. Lyell the ironstone, principally micaceous Hematite and Limonite, contains more or less free gold, which is also the case with the Baryte, Pyrites, and

Native Copper occurring at the same locality; at the Specimen Reef Mine and other places near the Savage River a large quantity of gold has been obtained in and closely associated with Siderite, which mineral appears to be the main matrix of the metal at this locality; at Lefroy and in the Fingal District when Galena is met with in the mines it often contains gold, and the small quantity of Sphalerite that occurs is invariably auriferous; at Waterhouse a considerable quantity of auriferous Mispickel and Marcasite occurs in the quartz reefs of the district, and the greater portion of the various pyritous minerals of the Beaconsfield, Lefroy, and Fingal gold mining districts are so rich in the precious metal as to make their metallurgic treatment of considerable importance to the various mines; at the Ring River the gold is commonly alloyed with a small quantity of Bismuth, a peculiarity not known to exist at any other locality in the island; in the vicinity of the Pieman River District the auriferous drifts often contain a comparatively large quantity of Osmiridium,—Badger Plain, near the Savage River, being a noted locality; in the stanniferous drift near Branxholm small flakes of gold are often met with, but not in sufficient quantity to render it of any economic importance; much of the alluvial gold obtained on the Lisle field is often coated with a dark, almost black substance, which is apparently Ferro-manganese; occurs sparingly in a soft silicious tufa, of a yellowish-brown colour in a body of considerable extent in connection with a dioritic rock at the Castray River. In the same formation grains of Iridium are often met with, and numerous fine grains of Titaniferous Iron. The average purity of the gold of this colony is about 96 per cent. the balance being usually the metals of the platinoid group. The largest nuggets of gold obtained in this island were discovered at the Rocky River, a tributary of the Pieman, in 1883. Their respective weights were 143 and 243 ozs.

Mr. F. Danvers Power, F.G.S., states, regarding the auriferous formation discovered at the Castray River, that "The country rock is slate, and on this has been deposited beds of volcanic ejecta; these latter are more or less auriferous. The volcanic material, where undecomposed, is green in colour and of compact texture, showing magnetic pyrites here and there distributed throughout it. As this becomes weathered it decomposes into a ferruginous clay, somewhat sandy, but various beds may be recognized by their structure, hardness, mottled appearance, or some other feature peculiar to them. The gold in this material is not evenly distributed; occasionally a rich patch is struck, but the bulk is unpayable. The whole deposit is a *fac simile* of one occurring at Mandurama, in New South Wales, where extensive work has been done; there, also, patches have been found, but the majority is too poor to pay." (Report on the New Castray Gold Mining Co's. blocks, 1891).

Information regarding the production of gold in this island is not available prior to 1860; from this year to the end of 1892 the total quantity obtained is estimated at 271,106 oz., valued at about £2,666,608, but large quantities are known to have left the colony by private hands from the alluvial districts generally, but more particularly from the western fields.

Decennial Return Showing Gold Produced.

Year.	Ozs.	Value.
		£
1883	46,577	176,442
1884	42,339	160,404
1885	41,240	155,309
1886	31,014	117,250
1887	42,609	158,533
1888	39,610	147,154
1889	32,332	119,703
1890	23,451	87,114
1891	39,203	149,816
1892	43,278	162,292

(The Returns obtained from the Tasmanian Official Record, 1892, and the Mines Department.)

102. GENTHITE (*Nickel Gymnite, Hydrated Silicate of Nickel and Magnesia*).

A few small specimens of a hydrated Silicate of Nickel, show- the clear characteristic apple-green colour, have been obtained in the workings of the Heazlewood Silver-lead Mine. They occurred as thin incrustrations, and apparently belong to this species, or at least to an analogous form.

103. GYPSUM (*Sulphate of Lime or Selenite*).

Abundant on the Grunter Hill, Upper Mersey River, in veins occurring in blue mountain limestone; the radiating cubical masses are of great size and iridescent appearance (W. R. Bell); Circular Pond Marsh, near Gad's Hill; in small lumps near Launceston; Gipps Creek, Ben Lomond; Mt. Horror; Zeehan; at Trial Harbour this is often met with forming radiating bunches attached to talc.

104. GLAUBER SALT (*Sulphate of Soda*).

On the floor of the caverns, intermixed with Native Alum as a powder of a dirty-white colour.

Alum Cliff; River Mersey, near Chudleigh.

104a. GIBBSITE (*Terhydrate of Alumina*).

A white incrusting mineral with an indistinct fibrous structure.

It occurs in coralloidal aggregations and mammillary patches implanted upon Limonite and Psilomelane.

Central Dundas and other mines, Dundas.

105. HYPERSTHENE (*Silicate of Magnesia, Calcium, and Iron*).

On the east side of the Parson's Hood Mountain. This mineral occurs with Schiller Spar and Dialage Rock; occasionally it contains specks of Copper Pyrites.

Fairly abundant at the Heazlewood; on the Forth River; Meredith Range; Dundas.

106. HYDROMAGNESITE (*Hydro-carbonate of Magnesia*).

An amorphous mineral resulting from the alteration of Brucite. It has not been found in a crystallized condition, its usual mode of occurrence being in the form of chalk-like crusts. In Serpentine with Brucite.

Heemskirk; (Ballarat School of Mines, Museum); of apparently rare occurrence in thin incrustations, Heazlewood.

107. HORNBLENDE (*Silicate of Lime, Magnesia, Iron, &c*).

Occurs massive, forming a large lenticular rock mass at Mount Ramsay. The rock is fine to fairly coarse subcrystalline structure of a black colour with a dull lustre. It in many respects resembles an analogous formation at Biggenden, Queensland; there is also a strong resemblance as regards the associated minerals, both containing the metal Bismuth, Pyrites of various kinds, and Gold. In the Biggenden mine the metallic minerals occur of a more oxidised or secondary character than at Mount Ramsay, but both have many striking points of resemblance to each other. The same variety of rock is also abundant at the Hampshire Hills, but without many of the minerals common to the Queensland locality and Mount Ramsay; columnar Hornblende occurs at a locality about six miles east of the Hampshire Hills and west of the Blythe River; it is found in combination with a large deposit of Magnetic Iron ore. The blades of this mineral, if they occurred without cleavage planes, could be obtained up to nearly two feet in length. The colour of the mineral is a very dark green to almost black; to the south-east of the Hampshire Hills a peculiar fibrous brown variety occurs. It is found in masses having much the appearance and structure of Chrokidolite from South Africa: examples have been broken out measuring above one foot in length. At the Heazlewood an extensive mass occurs which is many feet in thickness; it occurs as aciculated crystals which are interlaced, forming an almost solid compact rock of a pale asparagus-green colour. On the western side of the Heazlewood River a dark grey coloured form has been found in considerable quantity.

Abundant near the Madam Melba mine, North Dundas; at the

Upper Arthur River it forms a rock of fine texture and intense black colour; at the head of the Savage River it occurs in large quantity as a rock of medium texture and dark colouration; at Dundas semi-serpentised Hornblende occurs as well as the characteristic form.

The crystals of Hornblende are always elongated, which is an important difference between that mineral and its congener Augite.

108. HALLOYSITE (*Hydrated Silicate of Alumina*).

Contains more Silica than Kaolin and more Alumina than Smectite, but all are very unsatisfactory species, as they certainly merge one with the other.

When containing an admixture of iron oxide it varies to a substance that is known as Bole.

Mount Claude; Mount Cameron; Heazlewood; Blue Tier; of a greenish-white colour with brecciated Ankerite, Dolomite, and Pyrites, Dundas; with Galena and Siderite, Dundas and Zeehan.

109. HALITE (*Chloride of Sodium*).

Occurs as a powdery incrustation, usually very impure.

Salt Pan Plains.

110. HEMATITE (*Peroxide of Iron*).

One of the most abundant and diffused minerals; it occurs in vast quantity at many localities, more especially throughout the northern portion of the island. Almost all the many forms it assumes have been obtained in more or less profusion; these may be divided into four principal groups, viz:—

1. *Specular Iron*—the crystallized form.

   "Hepatic form in well defined crystals in the south end of Flinders Island, on the beach in Basalt, south-west of Mount Eliza," (Gould, Pro. Royal Society Tasmania, 1871). Forth River; Black Bluff Mountain; Arthur River, near the Hellyer; Dial Range, with manganese oxide; Mount Lyell; Ilfracombe; Blythe, Leven, Forth, and Penguin Rivers; Meredith Range; at Ilfracombe a variety occurs which has been termed "Needle Ore," the crystals are often of considerable size and much intermixed.

2. *Massive, or Red Hematite.*

   Forth River, near its junction with the Dove; it is foliated and has a highly brilliant lustre; it occurs in a quartz porphyry and covers a considerable area; at the Blythe an enormous mass occurs in practically an inexhaustible quantity and very good quality; on the west bank of the Tamar extensive deposits exist which have been economically worked; Circular Head; Blue Tier; Mount Heemskirk; King River; Pieman River; Flinders Island; Arthur River; Dial Range and Mount Lyell; many other places.

3. *Micaceous.*
   Of minute scaly structure. Whyte River, in quartz; Mount Reid; Macquarie Harbour; Pieman River; Dundas; Mount Heemskirk; Mount Lyell, where it is in part highly auriferous. At this locality a variety occurs in minute crystals, forming a black powder which is reported to be also auriferous: assays have been made up to 15 ozs. of gold per ton of material.
4. *Reddle.*—Red ochre or earthy oxide.
   This variety commonly occurs with the other forms from which it is disintegrated; it is often impure by admixture with earthy matter. Occurs in considerable abundance at many places on the West Tamar and along the north-west portion of the island; Flinders Island; Mount Lyell, where it is often intimately mixed with powdery Baryte, in which state it has been termed "Volcanic Mud;" and Crocus; at this locality it often contains free gold.

It has been stated ("Tasmania and its Mineral Resources, 1888"), that "early in the century Lieut.-Governor Collins forwarded a quantity of the ore to England, but without practical results, though Mr. Commissioner Bigge subsequently stated in his report on the trade and agriculture of New South Wales (of which this colony was then a dependency), that analysis made in England passed it ' to consist of pure protoxide of iron, similar to the black ore of Sweden, and furnishing a very pure and malleable metal." Surveyor-General Evans states ("A Geographical, Historical, and Topographical description of Van Diemen's Land, 1822"), "Within a few miles of Launceston there is a most surprising abundance of iron. Literally speaking, there are entire mountains of the ore, which is so remarkably rich that it has been found to yield seventy per cent. of pure metal."

111. HUASCOLITE (*Sulphide of Lead and Zinc*).

Occurs in large to small blocks and masses in the workings of the Godkin Extended mine, Whyte River. The ore occurs loosely imbedded in a friable granular sandstone and pug, the latter apparently resulting from the decomposition of primary sulphide minerals. In the loosely aggregated rock, and more rarely in the mineral itself, indistinct fossil shell casts occur, so that it is reasonable to infer that this mineral may be a secondary deposition of marine origin, formed from a sediment charged with mineral matter derived from the detrition of a lode which so far has not been discovered. In the same formation blocks of Galena and "slugs" of Silver Glance and argentiferous Pyrites also occur, the whole giving high assay returns of Silver.

112. HALOTRICHITE (*An Iron Alum*).

Found in fibrous silky masses of pale colour.
West Coast (Technological Museum Collection, Melbourne).

113. IRON, METEORIC, (*Iron, Nickel, &c*).

A remarkably fine sample of this interesting substance weighing nearly 3 lbs. was obtained some years back at the Blue Tier, north-east coast; it was found in stanniferous drift by a party of miners, and so excited their curiosity that they retained the specimen which is now in my collection.

This Meteorite is coated with a semi-polished crust much darker in colour than its general outer surface, much of which is apparently worn by attrition and is then coloured by iron oxide. The surface generally contains numerous shallow cavities or pittings, the major portion of which contain a white dull substance showing grains of mica—this is probably granitic grit. The fractured surface discloses a very white metallic iron which is finely granulated with an indistinct striated structure, exactly as if it would clearly show the Widmannstetten figures if polished. As far as I am aware this is the only instance of a discovery of a meteorite that has occurred in this island.

114. IDOCRASE (*Silicate of Calcium and Alumina coloured with Iron.*

Mount Ramsay. (J. Smith.)

115. ILVAITE (*Silicate of Iron and Calcium, colour black*).

St. Paul's Plains. (Pro. Royal Soc. Tas., 1853.)

116. IODYRITE (*Iodide of Silver*).

This important and somewhat rare ore of Silver usually occurs of a pale yellow colour, and when in crystals they are of hexagonal form. It has been obtained in small quantity at the Washington Hay Silver Mine, Heazlewood. (C. F. Heathcote).

117. IOLITE (*Silicate of Alumina, Magnesia, and Iron*).

Of a pale blue colour from a vugh.
Hampshire Silver Mine, Hampshire Hills. (W. R. Bell.)

118. JAMIESONITE (*Sulphantimonite of Lead*).

Occurs in somewhat large quantity at the Silver Cliff and the old Waratah mines at Mount Bischoff. At this locality its common mode of occurrence is filiform and amorphous, the entangled fibres often forming large masses of a dark, almost black colour. At the Madam Melba mine at Dundas it was discovered forming a dense compact lode, the fractures of which contained bands and coatings of the mixed oxides of Antimony and Lead. At this locality it occasionally forms bunches of fine acicular crystals which are implanted upon brown spar, and it is not uncommonly intermixed with Boulangerite and Galena.

119. KAOLINITE (*Hydrated Silicate of Alumina*).

The ordinary Porcelain Clay or Kaolin, which, when pure, contains no alkaline matter and should not fuse; but the majority of substances that are locally termed "Kaolin" are to a more or less degree fusible, and therefore impure. The more alkaline matter contained in a substance the more fusible it becomes; when this is the case it probably belongs to some other form of clay-like mineral.

In abundance, of good quality, Killicrankie Bay, Flinders Island; Circular Head; Piper River, in extensive beds; Mt. Claude; Middlesex Plains; Mt. Housetop; Mt. Bischoff; Derby, and places on the north-eastern tin field; about one mile south of Alford, Lower Piper River.

120. KAMMERERITE (*a Ripidolite, coloured Red by Chromic Acid*).

Occurs massive and granular in Serpentine with Magnetite, North Dundas. (Stitt and Cullingsworth, in Tasmanian Exhibition Collection, 1891.)

121. KERMESITE (*Sulphide of Oxide of Antimony*).

A mineral supposed to be this occurs as small red crystals, Hay's P. A. Mine, Castray River.

122. KYANITE (*Anhydrous Silicate of Alumina*).

In characteristic prisms of a pale blue colour, under Mount Cameron; near the River Forth (J. Smith).

Clayton Rivulet (Gould, Pro. Royal Soc. Tas., 1873).

123. LIMONITE (*Hydrated Peroxide of Iron*).

In fibrous radiating masses, Emu River, south of Hampshire (W. R. Bell). At Dundas this mineral occurs pseudomorphous after Siderite, and is then known locally as "Tomahawk Iron." On the banks of the River Tamar extinct Tertiary forms of several species of fresh-water shells belonging to the genus Unio occur, similarly changed to Limonite. At Beaconsfield crystals of Pyrites have been found also altered to this mineral, and at Bischoff it forms a portion of the "Brown Face," which was apparently originally a huge mass of Pyrites containing disseminated Cassiterite, Abundant at the Vale of Belvoir as a secondary formation in concretionary masses, often of peculiar form and variously coloured; plentiful at Zeehan and Dundas, often forming portion of the cappings of argentiferous lodes; abundant at the Heazlewood; Meredith Range; Savage River; Ilfracombe; Beaconsfield; Blythe; Dial Range; Mount Claude; Middlesex; Mount Housetop; Mount Lyell; King River: Mount Ramsay; in fine cubes after Pyrites, Savage River; and many other localities.

Limonite is not a good mineral species, as the amount of hydration varies very much and it does not crystallize. The streak is always yellow, by which it may be known from Hematite and Magnetite. It often forms a cementing medium in breccias and conglomerates.

124. LEPIDOMELANE (*Silicate of Iron, Alumina, and Potash*).

A dark coloured variety of Mica occurring in Granite near the contact of plutomic and sedimentary rocks.

Mount Heemskirk; North-east Coast.

125. LABRADORITE (*Silicate of Alumina, Calcium, and Soda*).

A variety of Felspar; it is a well known constituent of certain rocks. Occurs in a blue slate in detached crystal forms. Arthur River near its junction with the Hellyer. (W. R. Bell.)

126. LIGNITE (*Brown Coal*).

A semi-formed coal, retaining the texture of the wood from which it was formed. Bischoff; Breadalbane; Evandale; Macquarie Harbour; Launceston; Young Town; Pig Island, and other places.

At Beaconsfield a peculiar variety is found, that appears to be close to a form that has been named Dopplerite. It is an extremely brittle, intensely black, highly polished, jet-like hydro-carbonaceous substance, that has been obtained from the Tasmania and other gold mines at Beaconsfield. It occurs at considerable depth from the surface in the workings of the mines, which are in Silurian strata and apparently originates from infiltrated water charged with organic matter. A mineral with much the same appearance and nature has been found in the Bischoff Silver-lead mine; it occurred filling cleavage planes and in vughs in the lode gangue; at the Upper Arthur River, about three miles from Bischoff, a similar substance occurs in a hard siliceous rock, again filling cavities.

127. LITHOMARGE (*Hydrated Silicate of Alumina*).

A soft unctuous clay-like substance, more or less coloured by Iron Oxide.

Near Conara; Piper River; Mount Claude; Flinders Island; Mount Bischoff. Abundant at Mount Lyell, often containing Native Copper; Blue Tier, near Beaconsfield; often met with on the North-east tin fields, where it apparently results from the decomposition of triclinic Felspars of stanniferous Granite.

128. LEAD, NATIVE.

I received two minute specimens of this rare native metal from the South Nevada mine at Dundas. One of these I carefully examined, with the result that it proved to be this metal.

129. LEPIDOLITE (*Lithia Mica*).

Occurs in a dyke between metamorphic slate and greenstone (Diorite). It varies in thickness from five to eight inches.

Mount Ramsay and near the Arthur River (W. R. Bell). The Mica of stanniferous matrices usually contains Lithia. North-east Coast.

130. LAUMONTITE (*Hydrated Silicate of Alumina and Calcium*).

A Zeolite of very decomposable nature, that occurs in cavities in a rock that abuts upon Granite. The colour is flesh-red, but fades on exposure. To preserve the specimens it is absolutely necessary to coat the mineral with a varnish or gum to exclude the air.

Hampshire Hills.

131. LEADHILLITE (*Sulphato-carbonate of Lead*).

This mineral is characterised by its pearly lustre on the cleavage face, grey colour, and chemical reactions.

At the Godkin mine, Whyte River, it is often met with in the form of amorphous nodular masses without any trace of crystallization; but more rarely minute crystals may be obtained attached to the larger lumps. It is found embedded in a Kaolinic substance, associated with earthy Pyromorphite and Cerussite. It also occurs at several of the Dundas mines, but always intimately mixed with allied lead minerals.

In Australia it commonly occurs, but, as here, in limited quantity and usually in the amorphous form.

132. MALACHITE (*Green Carbonate of Copper*).

This mineral, which is so abundant at several of the mining districts of Australia, is here comparatively rare, and only known to occur in a thin coating or incrustation.

Heazlewood; Cascade; Mackintosh River; Badger Head; Frankford, &c.

133. MELANTERITE (*Iron Vitriol*).

Doubtless originates from the decomposition of Pyrites: it is usually found in old mine workings where there is a percolation of water.

In adit level, Bischoff; Silver Crown mine, Zeehan; Blue Tier, near Beaconsfield.

134. MORENOSITE (*Nickel Vitriol, or Sulphate*).

This vitriol occurs as a greenish-white efflorescence in mine workings. It was obtained by Mr. G. Thereau, F.G.S. (Report on the future Prospects as regards Production and Permanency of the Beaconsfield and Salisbury Mining Districts, 1883), in an adit on the property of the Victoria Gold Mining Company, Blue Tier, near Beaconsfield. An analysis made by Mr. W. F. Ward, Government Analyst (*loc. cit.*), "from selected portions of the mineral," gave the following return:—

Nickel Oxide	9·15	per cent.
Iron Protoxide	1·08	"
Sulphuric Acid	34·20	"
Water	44·80	"

At this mine, and on the Blue Tier Company's property in the vicinity, tunnels have been driven for a considerable distance into the range, which, after passing through a disturbed formation, penetrated a large quantity of pyrites of various kinds that soon decomposed, forming a mass of sulphates much intermixed deposited upon the sides and roof of the adits, giving off a considerable evolution of heat. These sulphates present a considerable admixture of bases: both occasionally show an efflorescent mass that can be fairly defined, but more often the forms cannot be separated, and it remains to be proved how far they may be homogeneously combined.

The "dyke" or lode appears to be composed of Quartz, Calcite, with Serpentine, and, according to Mr. Thureau's Report, Felspar, intermixed with the slaty country rock. It is thickly charged with Pyrite, Sphalerite, Millerite and Pyrrhotine—the first often highly auriferous.

Mr. W. F. Ward (*loc. cit.*) has made a careful and instructive examination of this interesting mineral mass: he states:—

"This mineral occurs in crystalline masses of a pale green colour, the cavities and parts of the surface being covered with minute hair-like crystals; the fracture is saccharoidal, and of a sea-green colour. The hardness is about 2; the taste metallic astringent; powder white; readily soluble in water. When gently treated it melts in its water of crystallization, afterwards intermixing and leaving a buff-coloured mass resembling pumice, which is infusible before the blowpipe, giving off sulphurous acid, and turning brown on the surface owing to the per-oxidation of the iron present.

The following shows the average composition:—

	Per cent.
Aluminium Sulphate	30·02
Nickel Sulphate	11·60
Magnesium Sulphate	4·95
Lime Sulphate	4·77
Iron (Ferrous) Sulphate	3·57
Water	44·90
	99·81
Metallic Nickel	4·40
Metallic Zinc	1·93

The formation of the mineral is doubtless due to the oxidation of Sulphides of Nickel, Zinc, and Iron in contact with rocks capable of yielding Alumina and Magnesia, which would explain the evolution of heat stated to occur during its production."

135. MAGNESITE (*Carbonate of Magnesia*).

Occurs in Serpentine, Parson's Hood Mountain; in veins, Trial Harbour; Meredith Range; Dundas; Heazlewood.

136. MARCASITE (*White Iron Pyrites*).

This species is dimorphous with ordinary Pyrite, but is paler in colour. It is apparently of more modern origin, as it is of common occurrence in Lignite, Coal, and Clays.

Often occurs in the Mersey and Don Coal Measures, near the Scamander River; Mount Heemskirk; Beaconsfield; St. Mary's; Waterhouse; and in small quantity in many other localities.

137. MAGNETITE (*Magnetic Iron Oxide*).

A remarkably pure highly magnetic form occurs in large quantity at the Hampshire Hills; it is somewhat granular in structure and presents a beautiful iridescent tarnish; fairly abundant in the vicinity of the Pieman River; Emu River; Ilfracombe. Abundant on the banks of a small tributary of the Blyth River, near Housetop Mountain; Mount Pelion; Dundas; and other places. Magnetite powders black, which is very characteristic. It is supposed that Hornblende, upon decomposition, often alters to this mineral.

138. MASSICOT (*Yellow Lead Oxide*).

Usually occurs as a powdery coating on the Sulphide or oxidised Lead ores; it is but rarely met with in a massive condition. It is often closely intermixed with the oxides of Antimony and Iron.

Obtained in comparatively large quantity with Galena, Cerussite and Anglesite, Mastrie's Broken Hill and Comet mines, Dundas; with Ferro-manganese, Cerussite and Galenite, but rarely associated with Crocoisite, Adelaide Proprietary; incrusting Jamiesonite and Galenite, usually intermixed with Antimonial Ochre, Madam Melba, North Dundas; in limited quantity at several of the Heazlewood and Zeehan Silver-lead mines.

At Dundas this ore gives high assay returns in Silver, which metal probably occurs as an intermixed Chloride.

139. MELACONITE (*Black Oxide of Copper*).

Rarely found in large quantity: its common mode of occurrence is as a thin coating upon other Copper minerals.

Star of Peace and Lone Hand mines, Cascade. At the latter locality it was met with disseminated and filling small pockets in the granite, often occurring with Chalcopyrite and Cassiterite; Penguin Copper mine with Pyrites and Grey Sulphide of Copper; Saxon's Creek, near Frankford, in the clefts of lode quartz with cupriferous Pyrites.

140. MATLOCKITE (*Oxychloride of Lead*).

In tabular crystals of a greenish-grey colour, apparently rare. Associated with mixed Sulphide and Carbonate ores. Sylvester Mine, Zeehan (A. J. Taylor). In small plates of a honey-yellow colour attached to Galena.

Montana S. M. Co., Zeehan.

141. MUSCOVITE (*Potash Mica*).

Foliated and flexible, from the Granite district between St. Valentine's Peak and Housetop Mountain (Pro. Royal Soc. Tas., 1851); in concretionary masses and crystals which are occasionally nearly one inch in length, Hampshire Hills; common in fair sized flakes, Flinders Island; George's Bay vicinity; West Coast; abundant on East Coast, in some places of a bright golden colour in minute flakes; Gould's Country. In the majority of stanniferous rocks, such as the Granites and Greisens, the Mica contains strong traces of the element Lithia. This mineral is the common light-coloured Mica so abundant in our Granite districts, of which rock it is an important constituent.

142. MOLYBDENITE (*Sulphide of Molybdenum*).

Abundant with Cassiterite at the Lottah and other mines at Blue Tier; Mount Heemskirk; at a locality six miles east of Hampshire and west of the Blythe River, with Magnetite and Hornblende (W. R. Bell); South Flinders and Cape Barren Islands; as small flaky masses in Quartz at the Iris River, near Middlesex; sparingly in Felspar at the Western Bluff; Castra, in felspathic porphyry; in Garnet rock, Upper Emu River; in a tough siliceous rock with columnar Hornblende at Heighwood, on the Upper Blythe River; Whyte River, with Garnet and Hornblende; Schouten Island.

143. MOLYBDINE (*Molybdic Acid or Oxide*).

Obtained in small quantity as a pulverulent incrustation of a clear yellow colour and dull earthly appearance on a hard dark coloured siliceous base at the Hampshire Silver mine (W. R. Bell); on lode-matter, mainly Greisen and Quartz Porphyry; as a thin powdery crust with Molybdenite, at the Blue Tier; on white opaque quartz at the River Iris with the Sulphide and Cassiterite.

144. MESOLITE (*Hydrated Silicate of Alumina, Lime, and Soda*).

A Zeolite occurring as small globules of a fibrous structure.

Near railway bridge, Hellyer River.

145. MIMETITE (*Phospho-Arseniate of Lead*).

Occurs in minute bunches of crystals on the wall of a lode at the Hampshire Silver mine. The groups of crystals are composed of aggregations of six-sided prisms, abruptly terminated at their apices, of a highly polished dark brown colour. They are of extreme rarity, and were only obtained in one portion of the lode. (W. R. Bell).

146. MIRABILITE—See GLAUBER SALT.

147. MARATITE (*Sulphide of Zinc and Iron*).

This is apparently a variety of Blende, portion of the Zinc being replaced by Iron. It is dark coloured, almost black, with a sub-metallic lustre.

Star of Peace Tin mine, Cascade; Rex's Hill, near Ben Lomond, Mount Bischoff.

148. MINERAL PITCH—See ASPHALTUM.

149. MILOSCHIN (*Chrome Ochre*).

A clay-like pulverulent or earthy mineral coloured green by Chromic Acid.

Blue Tier, near Beaconsfield; Dundas; near Mount Claude.

150. MENACCANITE (*Titanic Iron Oxide*).

This is the "Black Jack" of the East Coast tin-miners. It is an extremely abundant mineral, its main localities being the Blue Tier; Cascade; Mount Claude; Denison; Dundas; Blythe River (blue-black to black); George's Bay, and other places. The variety Nigrine is said to occur abundantly at Rocky Point, West Coast; Franklin Harbour. (Ballarat School of Mines Museum.)

151. MONTRONITE (*Hydrated Silicate of Iron*).

Always of a dull greenish colour, with an unctuous feel and waxy lustre. Found massive, with a conchoidal fracture. Occurs near New Norfolk; Hampshire Hills. (Melbourne Technological Museum Collection).

152. MINIUM (*Red Oxide of Lead*).

Occurs as a pulverulent coating on other Lead minerals and lode-matter. The colour is an unmistakable bright red, with a feeble lustre.

Whyte River Silver-lead mine.

At the Adelaide Proprietary, Dundas, the Cerussite crystals are occasionally pitted with a dull black lead oxide which may be this species discoloured with powdery Manganese, or it may prove to be its more rare congener the binoxide (Plattnerite). The minute quantity noticed prevents a careful examination.

153. MARMOLITE (*Foliated Serpentine*).

Our Serpentines vary to a considerable extent both in colour and structure, and they include the major portion of the described variations.

Bonanza mine, Dundas (Montgomery).

154. MERCURY, NATIVE.

As minute globules distributed throughout a siliceous slate-rock which is coloured by organic matter. Native Gold-amalgam or "White Gold" of the prospectors is reported to occur with it, but this statement requires confirmation.

A short distance north of the Linda River, near Mount Lyell. (Alfred J. Taylor.)

155. MELANOCHROITE (*Chromate of Lead*).

This form of Lead Chromate mainly differs from Crocoisite in its darker colour and brick-red streak.

Judging from the small quantity obtained it appears to be of rare occurrence: that examined was found in some specimens of ferro-manganese gossan from the Adelaide Proprietary mine at Dundas. It occurred in small amorphous patches mixed with larger masses of its congener and flakes of Galena.

Hitherto its only recorded locality has been the Silver-lead mines of the Ural, Siberia, so that its detection here is of interest to mineralogists.

156. MILLERITE (*Sulphide of Nickel*).

Occurs in delicate capillary filaments of various shades of yellow, sometimes with an iridescent tarnish. The pure mineral contains 64°/₀ of metallic Nickel. The occurrence of several species of nickelliferous minerals in the north-western portion of the island is of some interest, and tends to the supposition that this metal may be discovered in payable quantity when a thorough search is made for it. It is almost needless to say that it is of great economic value. Mr. G. Thureau, F.G.S. (Report on the future Prospects as regards Production and Permanency of the Beaconsfield and Salisbury Mining Districts, 1883), states that, "This mineral occurs in a dyke of intrusive rock, Quartzose, Felspathic, and apparently Porphyritic, containing in the joints Millerite, which shows various shades of yellow, in brittle capillary crystals, with other Sulphides"; reported to occur at the Penguin River with Galena and other minerals.

157. NICCOLITE (*Arsenical Nickel*).

This species is of doubtful identification. I am informed that it was found in limited quantity with Galena and Pyrites, at the Penguin River. As the mines at this locality have been shut down for some time it is impossible to obtain an example for examination. It is probable that nickelliferous Pyrrhotite has been mistaken for this mineral. An assay made by Mr. Cosmo Newberry in 1870, of mixed Arsenides and Sulphides, gave a return of 5 per cent. Cobalt and 3 per cent. Nickel (Just, "Tasmaniana," 1879).

158. NATROLITE (*Hydrated Silicate of Alumina and Soda, variety—Radiolite*).

A Zeolite occurring as thin white films, with radiating structure, in clefts of the diabase rock at Launceston. The identification is doubtful.

159. ORTHOCLASE (*Potash Felspar*).

Exceptionally beautiful crystals of Felspar occur in the neighbour- of Kilicrankie Bay, Flinders Island (Gould, Proceedings Royal Society Tasmania, 1871). Abundant in fine crystals which are often three inches in length, of a milky-white to yellow-brown colour, which occur embedded and implanted in a siliceous magma at the Great Republic mine, Ben Lomond; plentiful about George's Bay; Mount Heemskirk, in the porphyry and granite of the locality; massive and highly crystalline, flesh-red in colour, on the east bank of the Mersey River above Gad's Hill; in dykes, of a white to pale green colour, on the west side of the Mersey, distant about two miles above the crossing, in large yellow crystals, forming a broad band in Granite rock. A dyke composed of a solid compact subcrystalline Felsite rock, yellowish-brown in colour, occurs on Ben Lomond, which penetrates and crosses the Granite near the Great Republic mine. This mass is impregnated with a considerable quantity of Galena which is irregularly dispersed throughout the mass in flaky particles and solid patches. The concentrated Sulphide assays fairly well in Silver, and also contains a small quantity of gold; a variety occurs at Harman's Rivulet, near the Parson's Hood as a band in the Granite in somewhat angulated crystals of a dull white: it probably belongs to the variety Albite; at Port Cygnet a white variety is plentiful, which is found in rather thin crystals about one inch in length. They are implanted in a grey magma in Porphyry.

Felspars of less defined character occur at several other localities.

160. OLIVINE—See CHRYSOLITE.

161. OSMIRIDIUM (*an Alloy of Osmium and Iridium*).

Found as thin, shining, tin-white scales of small size, with Gold and Iridium, in alluvial drift. At the Badger Gold diggings, west of the Savage River, which is a tributary of the Pieman, it was obtained in considerable quantity of the characteristic form, but occasional pieces were obtained of unusually large size—one example measuring about ⅞ of an inch in diameter. At the Castray River fine scaly pieces are often obtained with gold and chromic-iron sand.

King River; Queen River; at Dundas it has been obtained attached to pieces of quartz; Brown's Plain and other places near the Pieman River.

This mineral as occurring in this island and in Australia invariably contains a small quantity of Platinum in alloy.

162. OBSIDIAN (*Volcanic Glass*).

Occurs in small quantity at the Mersey River; stated to exist in Gould's Country; it has been found in circular and concave or button-like flakes of an intense black colour in stanniferous drift, apparently igneous ejectamenta, Thomas's Plains; as massive lumps with Pitchstone and Olivine. Sheffield.

163. OLIGOCLASE (*Soda Felspar*).

This is a much scarcer form of Felspar than Orthoclase. It is usually of pale tints and more or less translucent.

In Porphyry, Blue Tier.

164. PHARMACOSIDERITE (*Arsenate of Iron*).

The primary form of crystallization in this mineral is the cube, by which character it may be separated from its chemical ally Scorodite—which is rhombic. In colouration it ranges through many shades of olive-green to brown. It is sectile, resinous, and is commonly found in the amorphous state or earthy.

Waterhouse.

165. PYROMORPHITE (*Chlorophosphate of Lead*).

This mineral can be readily identified by its crystallization, which is in hexagonal prisms, usually aggregated together in bunches and masses. In colour it shows gradations through many shades of green, rarely brown to almost white.

At the Godkin mine, Whyte River, it occurs in minute crystals, and as large massive amorphous earthy lumps, which are generally mixed with a kaolinic clay and more rarely Pyrolusite; at the Heazlewood mine it is found in microscopic crystals, which are almost colourless to the normal green prisms; the Sylvester mine at Zeehan has produced the largest and most beautiful masses of this mineral; the bunches of crystals are intricately interwoven and are of a somewhat unusually dark green colour; it is often more or less associated with Cerussite and other lead minerals; it also occurs in more or less quantity in many of our silver-lead mines at Zeehan, Dundas, and the Heazlewood; in small vein with cupriferous pyrites and galena in quartz, River Lee (James Smith). Pyromorphite is usually found at some distance from the surface as the result of the alteration of a pre-existing mineral, probably Galena.

166. PICROLITE (*Fibrous Serpentine*).

A pale-green radiating variety of Serpentine, often translucent and asbestiform. Occurs with Bastite and Chrysotile at Dundas.

167. PLUMBOCALCITE (*Carbonate of Lead and Lime*).

In physical appearance this species has the ordinary characteristics of a dark-coloured Calcite.

Several small specimens have been obtained at the Bell's Reward mine at the Heazlewood.

168. PROUSTITE (*Sulphide of Silver and Arsenic*).

Ruby-silver is of extreme rarity; it was found at the Bell's Reward mine in the form of very minute crystals of a clear crimson-red colour implanted on Calcite, with small crystals of galena and red blende.

169. POLYSPHÆRITE (*Phosphate of Lead and Calcium*).

Occurs as minute rounded pellets which have an internally radiated structure: colour usually brown with a somewhat greasy appearance. It is found intimately associated with bunches of Pyromorphite and Cerussite.

Sylvester Silver mine, Zeehan. (Alfred J. Taylor.)

170. PYROLUSITE (*Oxide of Manganese*).

An abundant and widely distributed mineral, commonly found in botryoidal, radiating, or granular masses, rarely crystallized. It is black or bluish-black in colour, and is much softer than Psilomelane.

Alluvial drift is often cemented into a compact mass by Ferro-Manganese, which is a mixture of this mineral and Limonite. Its more important localities in this island are:—Penguin River; Heazlewood; Vale of Belvoir; Mount Claude; Zeehan; Dundas; Meredith Range; Pieman River; Fingal and the Dial Range. At the Balstrup Manganese Hill mine at Zeehan small crystals occur intermixed with the more profuse radiated masses; Mount Zeehan in flattened bundles of acicular prisms on Limonite. (Ballarat School of Mines Museum.)

171. PSILOMELANE (*Oxide of Manganese*).

Equally as abundant as the last mentioned and often associated with it. A common mode of occurrence is of stalactitic form as well as arborescent groups of dentritic markings caused by the infiltration of this mineral in the crevices and fractures of rocks. It always occurs amorphous, opaque, and of dark colouration. Common at the Penguin River; Heazlewood; Dundas; Zeehan; Magnet Range, and many other localities in lesser quantity.

172. PLAGIONITE (*Sulphantimonite of Lead*).

Occurs as indistinct oblique tabular crystallizations, and as massive pieces of small size. The colour of the samples obtained is a dark lead-grey, but it is generally tarnished. The identification is uncertain.

Heazlewood.

173. PRZIBRAMITE (*Sulphide of Zinc and Cadmium*).

Cadmiferous blende occurs massive and in considerable quantity near the Scamander River on the East Coast, at several localities in the Ben Lomond district, and more sparingly at the Heazlewood.

174. PHOLERITE (*Hydrated Silicate of Alumina or Hydromica*).

A soft and friable substance, with a submetallic appearance and scaly structure.

Mount Bischoff (?); West Coast (exact locality uncertain).

175. PHILLIPSITE (*Hydrated Silicate of Alumina, Calcium, and Potash*).

Somewhat abundant in vesicular Basalt with other forms of zeolitic minerals. It invariably occurs in compound groups of crystals.

Near the railway bridge crossing the Hellyer River.

176. PYROPHYLLITE (*Hydrated Silicate of Alumina*).

In small radiated masses, which are sometimes foliated; it has a subtransparent pearly lustre.

Near Oatlands (granular and subcrystalline); Bischoff; Table Cape.

177. PORCELLANITE (*Silicate of Alumina*).

A milk-white compact porcelain-like substance of close, even texture, probably clay altered by heat.

Mount Lyell.

178. PIMELITE (*Hydrated Silicate of Alumina, Nickel and Magnesia*).

Always of an apple-green colour. Occurs rarely as small nodular masses in the Heazlewood Silver-lead mine with Siderite, which is commonly more or less stained with Chrome and Nickel oxides, Sphalerite, Galena, and other minerals.

179. PLEONASTE (*Black Spinel*).

The red or other coloured Spinels are not known to occur in the island, but the black variety is very abundant in tin-drift: it occurs as waterworn lumps, which are usually of small size: occasionally the crystallization is fairly defined.

Weldborough; Blue Tier; Moorina; Branxholm; Denison; Mount Maurice; Blyth River; Mount Cameron; Hampshire Hills. This is one of the minerals termed "Black-Jack" by the miners.

180. PITTICITE (*Arsenio-sulphate of Iron*).

Several small specimens of this rare mineral have been obtained near the Scamander River.

181. PITCHSTONE (*a variety of Obsidian*).

This remarkable and interesting substance is, as a rule, of an intensely black colour with a shining vitreous lustre and often extremely vesicular, the cavities being usually lined and occasionally completely filled with pure white Calcite or a magma of zeolitic material. It is but rarely that the species of Zeolite can be differentiated. It was met with in sinking a well in the township of Sheffield.

Mr. A.W. Clarke, F.G.S., has made a careful micro-examination of this substance. The following is a copy of his report relating thereto ("The Geology and Palæontology of Queensland and New Guinea," by R. L. Jack, F.G.S., &c., and R. Etheridge, jun., 1892):—"No. 196, Sheffield (Tasmania), R. L. Jack's collection. Colour black, vitreous. Glass with clear little white crystals. This is by far the most beautiful example of Pitchstone I have yet seen. The crystals are olivine, and they are mostly preserved in equisitely regular forms in the glass: the faces oP (·001) are wanting. The section being a little thick and the glass very transparent, together with their high angle of refraction, enables one to recognise in these crystals many of the characteristic planes of the typical olivine crystal. In this rock students of microscopical crystallography have an opportunity of studying olivine in a perfect crystal form. Under the ¼-inch objective the olivines are seen to include glass with fixed glass bubbles. The glassy base carries nothing else but opaque dusty matter in spots, which is probably a darker glass nucleus fringed with dusty matter, in whose neighbourhood gas bubbles are commonly found. The glass has bubbles at tolerably regular intervals, and in one or two cases bubbles are strung out in shapes or outlines. The microlites are very small, and play no great part in the constitution of the rock. They are tabular felspars, not unlike the New Guinea felspars in obsidian, described in the No. 1 of the Rhyolites."

182. PHACOLITE (*Hydrated Silicate of Alumina and Calcium*).

A variety of the zeolitic mineral Chabasite, which occurs in modified crystals of lenticular form. It is abundant in basalt rocks. Near Waratah; Hellyer River; Lefroy; Sheffield; Springfield.

183. PENTLANDITE (*Iron-nickel Pyrites*).

As small irregular patches of metallic lustre, with Magnetite, Zaratite, and Serpentine.

Heazlewood. (Montgomery.)

184. PYCNITE (*a variety of Topaz of cylindrical form*).

Occurs scattered throughout Quartz-porphyry. Mt. Bischoff.

185. PLATINUM.

This has been reported to occur at St. Paul's River; Pieman River gold-field; in auriferous drift as minute flakes, but occasionally in the form of small cubes, Blue Tier, near Beaconsfield.

186. PLUMBOGUMMITE (*Hydrated Phosphate of Lead and Alumina*).

Occurs in stalactitic and irregular globular forms of a pale-brown colour and resinous lustre.

British Zeehan mine, Zeehan.

187. PERICLASITE (*Oxide of Magnesia*).

River Don (James Smith); as a vein in Serpentine, sometimes enclosing lumps of that mineral; it is white and compact. North of Trial Harbour, near the Pulpit Rock.

188. PYRITES (*Sulphide of Iron*).

This well known mineral is generally diffused throughout the metalliferous districts of the island; it occurs—primary or secondary—in rocks of all geological ages. The auriferous form occurs at Beaconsfield, Lefroy, and Mathinna. Well-formed crystals are plentiful at Beaconsfield; Zeehan; Dial Range, and Bischoff.

Massive, granular, and sub-crystalline formations of large size have been discovered at Mt. Lyell, Mt. Reed, and the Dial Range; on the Forth River between Mt. Claude and Middlesex Plains a very large band occurs between Mica Schist and metamorphic Slate—it is said to be auriferous; occasionally obtained decomposed to brown hematite at Dundas and Beaconsfield; an extensive cupriferous pyrites formation reported to be about 140 feet in width has been exposed at Mt. Lyell, which is stated to average 4·5 per cent. of metallic Copper, 3 dwts. of Gold, and a small amount of Silver per ton of normal ore. On the surface this mass is altered to various forms of iron oxide.

189. PYRRHOTITE (*Magnetic Pyrites*).

Occurs as a large massive lode formation near George's Bay; at Mount Ramsay in amphibole rock with native Bismuth and other minerals; in main adit at Mount Bischoff the samples weather to a bronze lustre; at Hampshire in amorphous masses which have a decided red tinge and also of a grey colour, disseminated in a hard metamorphic rock; Penguin River, where it is highly nickeliferous; Dundas, said also to carry Nickel; samples from the Blue Tier, near Beaconsfield, have been found to contain Nickel, and in the old adits the mineral has decomposed to a mixed sulphate of that metal and iron; Beaconsfield, where it is often auriferous; Mount Pelion, in large masses.

190. PYROXENE (*Bisilicate of various bases*).

Abundant at the Upper Emu River; near the Whyte River it occurs sparingly. This species is identical with Augite, but the latter term is usually applied to the dark-coloured specimens.

191. PENNITE (*Hydro-nickel Magnesite*).

Occurs as a pale and somewhat dull incrustation on Chromite and Magnetite with Zaratite, from the latter it differs in containing Magnesia Carbonate. Heazlewood.

192. QUARTZ (*Silica*).

This abundant and widely diffused mineral is common both in the amorphous and crystallized form. The crystals occur as hexagonal prisms which sometimes have pyramidal terminations at both ends. It is found in many parts of the island, often in considerable abundance. The crystallized form more especially is met with in profusion in the tin-mining districts, where examples of large size, more or less waterworn, and showing a wide range of colouration, form one of the main features of the stanniferous drift. On Flinders Island and in the vicinity of Mount Cameron individual crystals weighing many pounds are commonly obtained; they are known as "rock crystal," and are beautiful representations of the species. In the auriferous districts the quartz is usually a more or less milky-white owing to enclosed vesicles, but extremely fine bunches of clear colourless crystals have been obtained at several localities. At the Heazlewood Quartz, often coloured green with the oxides of Chrome and Nickel, is an abundant admixture in the lode gangue of the Silver-lead mines, and on the West Coast crystals coloured red with Iron Oxide have been obtained. At Beaconsfield a honeycombed form occurs; this apparently originates from the decomposition of Pyrites: masses of a similar character have been found at the Pieman River and other places.

At the Vale of Belvoir Quartz occurs pseudomorphous after Tremolite and silicified wood, which is of similar origin; is abundant in many places. At Ben Lomond, in the workings of one of the tin mines, quartz has been found pseudomorphous after Felspar; the specimens have a peculiar mottled appearance of various shades of brown.

Endomorphs in quartz, which is usually more or less cloudy in appearance from enclosed substances:—

Rutile.—Moorina; Mount Cameron.

Cassiterite.—Gould's Country.

Tourmaline.—Ben Lomond; Moorina; Mount Heemskirk.

Iron Oxide.—In capillary fibres (known as Venus Hair Stone), Kindred Road, near the River Forth.

Manganite.—In solid dentrites in semi-opal, North-east Coast.

Principal varieties of Quartz.

Rock-crystal.—Vitreous form with a glassy appearance, commonly transparent and colourless, but occasionally tinted with yellow and brown. Mount Cameron; Gould's Country; Moorina; Thomas's Plains; Lefroy; Mount Maurice; Mount Heemskirk; Beaconsfield; Dundas; Ben Lomond; Flinders and other islands in Bass Straits, and other localities.

Cairngorm.—Smoky-brown, of various shades. Blue Tier; Moorina; Mount Cameron; Flinders Island, &c.

False-topaz.—Of a clear pellucid yellow colour. Mount Cameron; Moorina; Gould's Country, &c.

Hyalite.—This variety has been found in the form of beautiful globular concretionary masses and incrustations with a pearly lustre. Zeehan; Gould's Country.

Resinite.—A form of semi-opal of dull brown colour and resin-like appearance. Flinders' Island.

Wood-opal.—Silicified wood, usually of a pale brown colouration, with a striated structure.

In drift Derby; Flinders' Island; Epping Forest; Longford; Launceston; in concentric layers, Franklin Rivulet; East Arm of Port Sorell; near Latrobe: Kentish Plains; white, of a fine silky texture, Queen River, east of Howard's Plain; of bright colouration and compact form, Little Forester River; Lake Sorell; Conara; Swansea; pseudomorphous after stems, Hobart; (Ballarat School of Mines Museum).

Cacholong.—A milk-white compact siliceous substance occuring as thin veins and filling cavities in Basalt; it is opaque and usually somewhat dull in lustre. Near Launceston.

Phrase.—Amorphous, usually of a yellowish-brown waxy lustre, Hampshire Hills; as brown to dark-green waterworn pebbles, Lake Sorell; with Adularia and ordinary Quartz in the Granite rock near its junction with metamorphic slate, Tasman Rivulet; a brown porcelaineous form is abundant at the Magnet Range.

Agate.—A variegated variety of quartz, the colours being arranged in bands, concentric layers, and cloudy masses. River Leven; Cranbrook, near Swansea; River Forth; Flinders' Island; Cornelian Bay; Lake Sorell; Heazlewood, and other places.

Morion.—Black Quartz. Blue Tier; Flinders' Island; Ben Lomond; a mammilated Black Quartz in a solid compact form occurs on the west branch of the Savage River, nearly opposite Long Plain.

Hornstone.—A variety resembling flint, opaque to translucent, dull and glimmering lustre. In colour from white to the black Lydian stone. Lilydale; Oyster Bay; Flinders' Island; Cornelian Bay; Mount Nelson; Mount Bischoff; Pieman River; Macquarie Harbour; River Forth, and elsewhere.

Common Opal.—An amorphous hydrated form of a milk-white to pale brown colour and vitreous lustre.

Port Cygnet; Lake Sorell; Cornelian Bay; Macquarie Harbour; Supply Creek; Mount Cameron; Pieman; Dugam Range, near the Montagu; Proctor's Road, near Hobart.

Menilite.—A dull brownish to white translucent variety of common Opal, occurring in irregular reniform lumps or nodules which are impressed on the surface with angular depressions. In stanniferous drift, Gould's Country.

Geyserite.—A white hydrated form occurring in cellular masses mixed with Native Sulphur. Mount Bischoff.

Rose-quartz.—Of rare occurrence, and then not nearly so clear as that obtained in Bavaria and other places. Local examples are generally somewhat ferruginous and cloudy.

West Coast: Beaconsfield; Moorina.

Amethyst.—Of a beautiful clear violet colour. A gem-stone much in use for ornamental work.

In large detached abraded crystals in stanniferous drift at Moorina; in the Emu River about four miles south of the Hampshire Hills; also occurs at Mount Cameron and Blue Tier.

Chalcedony.—Semi-transparent with a waxy lustre, often in mammillated form, but never in a crystallized condition.

Of a greenish and brown colour, apparently infiltered in cavities and seams at Beaconsfield; in banded brown-coloured masses at Flinders' Island; as waterworn pebbles, Swanport; Lake Sorell; Tamar Heads; Cornelian Bay; Lisle; Mount Cameron; Meredith Range; Heazlewood; Pieman River; Zeehan.

Cornelian.—Of a more or less variegated red colouration, often banded with white and yellow, and sometimes showing crystalline aggregations.

Fingal; Flinders' Island; Swansea; River Forth; Cornelian

Bay; Lake Sorell; Ilfracombe; Supply Creek; Longford, and many other localities.

193. RETINITE (?) (*Fossil Resin*).

A brownish-yellow hydro-carbonaceous substance of semi-perlaceous lustre, very brittle, soft, and of uneven fracture. When heated melts to a dark brown varnish-like mass, burns with a yellow flame, during which it gives off much smoke: it emits a strong resinous aromatic odour.

A sample of this material was submitted to Professor Krause, of the Ballarat School of Mines, who stated that it comes near to a fossil resin that has been named Middletonite, and that he found a similar substance in Victoria many years ago occurring between beds of coal. A partial analysis has been made by Mr. C. Burbury, who states that "it contains 1·75 °/o moisture at 100° C., and (by usual treatment of coal) 98°/o of volatile Hydrocarbons."

Occurs above and impregnating beds of lignitic coal at Macquarie Harbour.

A similar substance was obtained, also with lignite, in a clay-slate rock, which contained many leaf impressions, at a depth of about 100 feet from the surface, at the Don Tin mine, Bischoff. A fossil resin has also been found in numerous small fragments in the lignite near Evandale Junction.

194. RUTILE (*Binoxide of Titanium*).

Abundant, but much rounded, in drift, Brown's Plains; Savage River; about the south-west base of Mount Lyell; in waterworn fragments and occasionally as well-formed crystals with other Titanium minerals, Clayton Rivulet; in red-brown to black capillary bunches penetrating Quartz crystals, Moorina.

195. RHODOCHROSITE (*Carbonate of Manganese*).

This well-marked mineral is also known as Dialogite: it has been obtained at the Austral Silver-lead mine, Zeehan, in ferro-manganese gossan, the vughs often containing fine aggregations of the substance; it also occurs massive in the fractures and in irregular botryoidal concretionary masses, lining cavities; it has also been found at the Maestrie's Broken Hill mine at Dundas.

196. RETINALITE (*Yellow Serpentine*).

A massive resinous yellow variety of this well-known mineral substance. It is usually translucent.

Dundas.

197. RHODONITE (*Silicate of Manganese*).

Information from Zeehan states that this mineral has been found there, but the statement requires confirmation. It usually occurs massive, opaque, and flesh-red in colour, often coated black externally from exposure. Some beautiful examples have been obtained from the New England District of New South Wales. (Cox and Ratte, "Mines and Minerals.")

198. RANDANITE (*Infusorial Earth*).

Found in small quantity; contains many fresh-water forms of Diatomaceæ.

Inglewood, near Oatlands, (Burbury).

199. STILBITE (*Hydrated Silicate of Alumina and Calcium*).

In a mineral vein on the west side of the River Mersey, a few miles above Gad's Hill crossing.

200. SILLIMANITE (*Anhydrous Silicate of Alumina*).

Occurs in small compact massive lumps of a brown to black colour with perfect and brilliant cleavage. It is translucent with a vitreous lustre.

Bischoff. (W. R. Bell).

201. SMITHSONITE (*Silicate of Zinc*).

Found in small compact patches, yellow-brown colour and dull lustre.

Bell's Reward, Whyte River, and at the Heazlewood Silver-lead mine, Heazlewood River.

202. SIDERITE (*Carbonate of Iron*).

Occurs of sub-crystalline structure and pale brown colour, with quartz, both of which often contain gold. Specimen Reef mine, Brown's Plain; in translucent masses of a vitreous appearance which rapidly weathers brown, also abundantly in the opaque form, but rarely in well-formed crystals, Mount Bischoff; in veins, usually of lenticular form and often containing Gold, Brown's Plain, Lucy River, Rocky River, and other places in the vicinity of the Pieman. This mineral appears to be the principal auriferous matrix of the locality: on the surface it is usually decomposed to the oxide. Abundant near the River Forth in compact masses; at Port Sorell it is found intermixed with quartz; in great profusion at Zeehan, Dundas, and the Heazlewood, where it forms the common lode gangue of the Silver-lead mines. The crystals are rarely obtained, but at the last-mentioned field they are occasionally met with, but very small in size: it is more often met with in the lode cavities in semi-lenticular forms aggregated together. In the Heazlewood Silver-lead and adjacent mines it is commonly coloured pale green by the admixture of the oxides o Nickel and Chrome.

203. STROMEYERITE (*Sulphide of Silver and Copper*).

When pure this mineral contains about 52 °/₀ of metallic silver; it crystallizes in the rhombic system, and is isomorphous with

Copper Glance. In colour it is steel-grey, with a metallic lustre and shining streak. It is soft and perfectly sectile. It occurs desseminated, with Bornite and Chalcopyrite, in a quartz matrix at Mount Lyell. Assays of the mixed material have given returns at the rate of several thousands of ounces of Silver to the ton of ore. It is reported to occur on the footwall of the extensive interbedded formation of cupriferous pyrites for which the locality is now well known. The only recorded Australian locality for this mineral is at the A. B. H. Consols mine at Broken Hill, N.S.W., where it is reported to occur in a matrix of Carbonate of Iron in a dyke of Amphibole; it was found in close association with Dyscrasite, Sternbergite, Pyrargyrite, and other uncommon argentiferous species. (Smith, *The Australian Mining Standard*, May 22, 1893).

204. SILVER, NATIVE.

The pure metal has been obtained as small frondose branching patches in gossan, Penguin Silver mine ; in clefts in lode material, Hampshire Silver mine ; on Galena in flaky attached masses, which are usually tarnished, Owen Meredith mine, Dundas; in and on Calcite and Ankerite with amorphous Blende and Galena, Godkin mine, Whyte River : at this locality some extremely fine specimens have been obtained, many showing beautiful arborescent clusters of minute crystals : the crystals are often fairly well formed ; it also occurs in somewhat long capillary masses and fibrous bunches, filling small vughs and coating the fractures ; at the Bell's Reward mine it has been obtained associated with crystals of Calcite, the thin wire-like sprays of Native Silver are sometimes interwoven between the Calcite crystals; it has been detected in stanniferous Granite in a dyke formation at the Blue Tier, with Chalcopyrite, Bismuth, and Fluorite as accessory minerals.

205. STILPHNOSIDERITE (*Hydrated Peroxide of Iron*).

Occurs of a dark blackish-brown colour with a conchoidal fracture, shining and brittle. It is generally found in a stalactitic form or as a varnish-like coating on Limonite or Manganese minerals—more particularly on Psilomelane. Central Dundas mine ; rarely Mount Bischoff; lining vughs of ironstone, with Cuprite, Mount Lyell ; Central Balstrup mine, Zeehan, coating masses of Limonite, which are commonly of stalactitic form.

206. STANNITE (*Sulphide of Iron, Copper, and Tin*).

Stated by Phillips (" Ore Deposits," 1884, page 505) to occur at Bischoff. The term is usually applied to the sulphide ore as above, but Bristow (" Glossary of Mineralogy," 1861) defines a substance under this name as a mechanical mixture of Quartz and Tin oxide ; if this definition is accepted then such an occurrence exists not only at Bischoff, but also in the Ben Lomond and other tin-mining districts.

The sulphide commonly known as Stannite (Dana "A Text-book of Mineralogy," 1885) is almost, if not quite peculiar to Cornwall, and has not so far been detected in this island.

This mineral is reported to occur in North Queensland and in New England, New South Wales. ("Report of the Second Meeting of the Australasian Association for the Advancement of Science, 1890," pages 215 and 260.)

207. STERNBERGITE (*Argento-pyrite*).

This species occurs with Huastolite and Galena in the workings of the Godkin Extended mine, at Heazlewood. An assay of a fairly pure specimen gave a very high return in Silver.

208. SPINEL, BLACK—See PLEONASTE.

209. SCHEELITE (*Tungstate of Calcium*).

At Mount Ramsay this occurs in the characteristic mineral-bearing hornblendic rock of the locality. It is found in well-formed crystals of considerable size, often up to one inch in length, and crystalline bunches. The colour is usually pale yellowish-brown, and in good specimens the facets are polished; in tabular crystals which are nearly white, Upper Emu River, in Garnet rock. (W. R. Bell.)

210. SMALTINE (*Arsenical Cobalt*).

Usually obtained in solid masses with a cubical fracture and of tin-white colour. It is said to occur in an almost solid vein or small lode at the North Pieman, also at the Hampshire Silver mine; in limited quantity, Penguin River; Castles Forbes Bay (Johnston, "Geology of Tasmania"); Mount Heemskirk with Cassiterite.

211. SAPPHIRE—See CORUNDUM.

212. SPHALERITE (*Zinc Sulphide or Blende*).

This mineral is of frequent occurrence, but not in great abundance at any of its many localities. It is often met with in comparatively limited quantity in the Silver-lead mines of Zeehan, Dundas, the Heazlewood, and at Ben Lomond. At the Silver Crown mine at Zeehan, bunches of somewhat large crystals occur of a brown colour; at the Godkin mine, Whyte River, a richly argentiferous Blende occurs in amorphous masses,—it is of a mahogany-brown colour with a dull lustre. It is found associated with patches of Native Silver and masses of Galena in a white and dark-coloured Calcite, and more rarely in Ankerite; at the Healzlewood Silver-lead and other mines in the vicinity, minute but remarkably well formed crystals are very abundant. They are of a clear yellow to red colour, and are usually obtained implanted in the fractures of Siderite or Quartz with crystals of

Galenite; at the Heazlewood mine it also occurs more rarely, in beautiful sharp-angled crystals which have a purple, green, and red metallic lustre; abundant in a massive form of a black colour, east branch of the Hellyer River; with the sulphides of Copper and Lead in an elvan of porphyry, opposite Gad's Hill, Mersey River, (W. R. Bell), plentifully and thickly disseminated in a vein at the Hampshire Silver mine, where it presents a peculiar copper-red colouration; Hunterston, on the Shannon, near Bothwell, (Pro. Royal Soc. Tas., 1854); of a dark brown to black colour with Chlorophane and various forms of Pyrites, Mount Bischoff; scattered throughout a dyke formation, with Galena in Granite rock, Meredith Range; as minute crystals of a pale green colour with Galena, Australasian mine, Dundas; in limited quantity, Ben Lomond; in a lode which is mainly composed of a mixture of this mineral, Arsenopyrite, and Galena, Scamander River; Penguin River Silver-lead mine; Mount Claude; Middlesex, with Pyrites and Galena; often highly auriferous, but in very small quantity, Lefroy and Mathinna; a peculiar variety of phosphorescent Blende occurs at the Castray River: it was obtained in trenching across a decomposed lode formation as rounded lumps, brown in colour, and of small size with masses of Galena and Pyrites as accessory minerals. The phosphorescent character is clearly distinct when struck or scraped with a knife blade. It is locally known as "Electric Calamine." At Mount Reed with Pyrites and Galena it is somewhat abundant.

Sphalerite often contains Gold, Silver, Cadmium, and the rare elements Thallium, Iridium, and Gallium.

213. SCORODITE (*Hydrated Arsenate of Iron*).

Formed by the decomposition of Marcasite, and usually found where that mineral is abundant. It is commonly met with at the Scamander River and vicinity; Golconda; Mount Bischoff; in the cavities of siliceous skeleton rock as beautiful green crystals at the Upper Emu River; amorphous in considerable quantity at the Waterhouse Gold field, at which locality it has been obtained in green-coloured crystals in the "Southern Cross" reef; near Mount Pelion, in quantity, the masses occasionally showing the gradual transmutation from the original mineral Arsenopyrite.

214. STEATITE (*Hydrated Silicate of Magnesia*).

Abundant with Asbestos and Serpentine, Asbestos Mountain; Mount Bischoff; Heazlewood; Beaconsfield; River Forth; near Mount Claude. "The Steatite contains a small vein of Silver, which, by the way, is not uncommon in this mineral, and is met with in most of the primitive mountains" (Pro. Royal Soc. Tas., 1854). This note refers to a specimen said to have been obtained at the Asbestos Mountain, but I have failed to detect any Silver in the numerous examples that I have examined.

215. SCHILLER SPAR (*a Hydrated Silicate of Magnesia*).

Occurs in many varieties on eastern side of the Parson's Hood Mountain; Heazlewood; Asbestos Mountain; Dundas; Magnet Range; Parson's Hood. The minerals termed Bronzite and Diallage are but varieties, and some authorities consider the whole but altered forms of Augite.

Bronzite is an essential constituent in the rock Gabbro so plentiful at the Heazlewood. It occurs of foliated structure and pale-green colour in Serpentine, Dundas. (Ballarat School of Mines Museum.) This species is also known as Bastite.

216. SERICITE (*Hydrated form of Mica*).

Occurs in foliations of schistose structure, colour greenish with a silky lustre. Dundas.

217. STEPHANITE (*Sulphide of Antimony and Silver*).

Reported as occurring at the Scamander Silver mine.

Scamander River, East Coast; at the Owen Meredith Silver mine it is found intermixed with Galena, the whole giving very high returns for Silver.

218. SULPHUR.

Found in the form of extremely minute crystals and microscopic patches in Galena. Mount Reid; British Zeehan Silver-lead mine, Zeehan; obtained in some quantity as a powdery mass composed of microscopic crystals intermixed with a pulverulent form of quartz (Geyserite), at Mount Bischoff. This discovery is interesting from the fact that it is the first of the substance in appreciable quantity that has occurred in this island.

219. SPHEROSIDERITE (*Carbonate of Iron*).

Of common occurrence in amygdaloidal Basalt in the form of small dark brown nodules. Rouse's Camp near Waratah; near the railway bridge that spans the Hellyer River.

220. STIBNITE (*Sulphide of Antimony*).

Found in massive irregular bunches in a quartz reef. The mineral was of the usual columnar structure, and of a remarkably pure character. Orlando Gold mine, Lefroy; in limited quantity south of Mount Claude, near the River Forth; impure and apparently merging to Jamesonite, Mount Bischoff; "Sulphide of Antimony, yielding 8 to 18 ozs. of Silver to the ton, from Mount Bischoff" (W. F. Ward, Tasmanian Official Record, 1892). I have not seen pure Stibnite from Mount Bischoff, although several antimonial minerals are abundant there.

221. SELENITE (*a variety of Gypsum*).

Occurs in more or less transparent laminæ. Obtained in small quantity at St. Mary's, and near Circular Pond Marsh (W. R. Bell).

222. SERPENTINE (*Hydrated Silicate of Magnesia*).

This mineral occurs as a rock mass of considerable extent. Its normal colour is green of many shades, but almost every known variety of the substance, both in colour and in structure, has been obtained in more or less quantity. The mineral Olivine is supposed to be transmutable to Serpentine under certain conditions. At the Heazlewood and vicinity it occurs in considerable quantity, often containing a perceptible amount of Nickel oxide, which gives it a bright apple-green colour, in which case it approaches that from New Caledonia, which is worked as an ore of Nickel. Along the banks of the Heazlewood River and some of the smaller streams much of the Serpentine often contains large quantities of minute intensely black crystals of Chromic Iron, and more rarely large amorphous bunches of the same mineral. Brucite, Schiller-spar, and narrow bands of Chrysolite also occur with it as accessory minerals; at Anderson's Creek and neighbourhood extensive masses of this rock exist, in many places containing a considerable quantity of asbestiform Chrysolite and Steatite; north of Trial Harbour it often contains long fibrous Asbestos, and is connected with an extensive bed of remarkably pure Talc; also occurs at Mount Ramsay, Pieman River, Mount Claude, Clayton Rivulet, and at the Parson's Hood Mountain; at Dundas a semi-serpentized Hornblende occurs intermixed with Bastite, and at the same locality a purple-coloured form is common, often containing disseminated Magnetite and Chromite.

223. STRONTIANITE (*Carbonate of Strontia*).

Found in small veins and pockets, usually of a white satiny appearance, at the Hampshire Silver mine (W. R. Bell). This species is not known to occur at any other locality in the island. It was obtained irregularly mixed up with lode-matter, with Fluor-spar, Apatite, and several minerals that are like it, almost peculiar to this interesting locality. "Mr. Gould recognised Strontium associated with heavy-spar in some minerals that I discovered at the Forth River."—(James Smith).

224. SEPTARIA (*Mixed amorphous Carbonates of Lime and Iron with more or less Silica*).

Rounded and occasionally flattened concretionary nodules, which are sometimes of considerable size—up to two feet in length —of a dirty white to brown colour. They have almost invariably a strong radiated structure.

Hampshire Hills (W. R. Bell).

225. TASMANITE.

A grey earthy to arenaceous shale more or less impregnated with circular, punctate, brown microscopic fossil spore cases of a highly resinous nature, which have been named *Tasmanites punctatus* (Newton).

The spores yield an oily product in considerably quantity, but of poor illuminatory power. As much as 100 gallons of oil has been obtained by distillation per ton of shale. In beds of considerable extent on the banks of the Mersey River.

The American black paraffin shale has been found to be extremely rich in spore-cases of a similar structure and character to those so abundant in Tasmanite. The origin of the shale is supposed by some authorities to have been the accumulation of the shell spores of a species of Marine *Algæ*, similar to that now existing in the Sargossa Sea.

Dana states ("A Text-book of Mineralogy") that this hydro-carbonaceous substance is "remarkable in containing sulphur, replacing part of the oxygen."

An analysis by Professor Penny (Pro. Royal Soc. Tas., 1855) gave the following results:—

Volatile matters		20·41
Coke	Fixed carbon	5·50
	Ash	71·20
Sulphur		·73
Water		2·16

226. TOURMALINE (*a compound Silicate of Alumina and several other elements*).

Crystallizes in the hexagonal system; the crystals when free are generally terminated differently at the opposite ends. Common in columnar forms, which are often radiating or divergent. Exhibits many varieties of colouration; in this island it is known to occur black, brown, and green.

Black Tourmaline or Schorl.—Occurs commonly in almost all our stanniferous granites; when in prisms it generally presents a more or less triangular section, the sides being strongly striated lengthways. It is often aggregated together in radiating masses, which are occasionally of considerable size.

Occurs abundantly in drift at Moorina, the individual prisms sometimes measuring over two and a half inches in diameter. Flinders Island, of large size, penetrating the granite rock and free waterworn lumps in the drift, with topaz and large quartz crystals; Mount Heemskirk, in the granite in massive and aggregated bunches; Ben Lomond, in considerable quantity, often containing Cassiterite in the interstices and closely associated; Branxholm, in the granite and as somewhat small crystals free in the drift; Blue Tier; Granite Tor; Mount Housetop; Mount Cameron, in fine highly polished prisms; Upper Blythe River, in short stout prisms, which are intensely black; Clarke's Island; Pieman River; Meredith Range, often imbedded and penetrating Quartz;

Cascade in abundance, commonly in radiating bunches, which are occasionally intermixed with Pyrites and Cassiterite; Mount Ramsay, in the stanniferous granite abutting on to Amphibole rock.

Green Tourmaline.—This is a peculiar and local form characteristic of Mount Bischoff, where it practically often constitutes a rock mass which has erroneously been termed Chlorite. The prisms are, as a rule, thin, rather dull in lustre, and of various shades of pale-green in colour. The crystals rarely exceed one inch in length, being commonly quite minute; they sometimes form small tufted masses, composed of fine acicular prisms, in cavities of the rock, but more often they are aggregated and intimately interwoven together, forming bunches of considerable proportions. The more commonly distributed black schorl has not been found at Mount Bischoff.

Brown Tourmaline.—Obtained in small radiating prisms in a quartz matrix at Mount Ramsay; at Glenora; near the gap at Mount Heemskirk, in some abundance, of a rather dull hair-brown colour.

Regarding the formation of Tourmaline in nature, the following remarks by Mr. A. W. Clarke, F.G.S., will be of considerable scientific interest, more especially as this learned gentleman's observations are based upon a studied microscopical examination (Jack and Etheridge, jun., "The Geology and Plæontology of Queensland and New Guinea," 1892):—"The interesting question arises, which of the two minerals"—referring to this mineral and quartz—"is the first born. Rosenbusch says ('Microscopical Physiography,' p. 184) that 'Tourmaline is not directly secreted out of the eruptive magma in eruptive rocks, but resulted from the action of fumaroles carrying Fluorine and Boron on the eruptive rock, especially in its Felspar and Mica.' Teall also alludes to the action of fumaroles in the genesis of Tourmaline. This would rather support the pre-existence of Quartz; on the other hand, the uniform orientation of the Quartz between and alongside of the broken prisms would lead one to think that the reverse was the case. Could it be that the Tourmaline crystallized out in the Quartz by the action of fumaroles, as above, while the Quartz was viscous and under pressure, and that earth-stresses and dynamic metamorphism followed, separating the prisms, after which the Quartz proceeded to crystallize?"

227. TREMOLITE (*a pale-coloured variety of Hornblende*).

A variety of a pale green to white colour, generally radiating in structure; is common at Wombat Hill, about three miles from Mount Bischoff; radiating in bunches, and also massive, white, and shining; in profusion at a locality about three miles west-north-west of Mount Horror; at Heazlewood in vughs in the country rock; at the Vale of Belvoir it occurs pseudomorphed to Quartz, in columnar blades often a foot in length: it is usually white and glassy; two miles east of the Parson's Hood Mountain, of a grey colour, compact in structure, and a somewhat dull surface; in the vicinity of Mount Pelion, in masses that are very pale in colour, almost white.

228. TETRAHEDRITE (*Fahlerz, Sulphide of Copper, Antimony, &c.*

This mineral is looked upon as a most important ore of Silver, not only because it is commonly rich in the desired metal, but also from the thoroughly established fact that it usually exists to great depth, so that its occurrence may, as a rule, be looked upon as predicting permanency in the metalliferous ore body in which it has been detected. It has long been the mainstay of the great mines of Saxony, where it has been worked for considerably over a century. It often contains a considerable admixture of other metals, such as Zinc, Iron, Lead, or even Mercury may be present, and still more rarely, Cobalt or Bismuth. It has been discovered massive and richly argentiferous at Dundas as a lode formation which is reported to be of considerable size. A qualitative analysis of this mineral shows it to be a remarkably pure form of Fahlerz: it is practically a Sulphide of Copper, Antimony, and Silver, the latter metal often giving assay returns of over 250 ozs. per ton of mineral. In this mine it is found associated with Chalcopyrite. Occurs in limited quantity with Galena and various forms of Pyrites, Penguin Silver mine; found in the form of scattered blebs and narrow compact seams in a silicious matrix, with Sphleraite, Jamiesonite, Galena, and other minerals, Hay's Prospecting Association, Castray River; it has also been reported to occur in several of the mines at Zeehan and Dundas; at Mount Lyell it is reported to occur in close association with cupriferous Pyrites; assays from this locality have given a return of above 2400 ozs. of Silver and 1 oz. of Gold per ton. The ore apparently occurs as amorphous lumps intermixed with the paler-coloured Pyrites. The manager of the Fahl Ore Silver Mining Company (Dundas) reports that "A sample of 1 cwt. of ore from this mine which was forwarded to Germany has given the following returns:—Copper, 26 per cent.; Antimony, 15·45 per cent.; Arsenic, 1·5 per cent.; and Silver, 0·75 per cent. (equal to 245 ozs. per ton)." Ferriferous Tetrahedrite in decomposed Hornblende rock, Dundas. (Ballarat School of Mines Museum).

229. THOMSONITE (*Hydrated Silicate of Alumina and Calcium*).

A zeolitic mineral occurring in Basalt rock, Sheffield; in small vughs, but the identification is somewhat doubtful, as the samples are small and indistinct, occurring in clusters of microscopic crystals which are of a yellow colour, coating the clefts of lode material. Hampshire Silver mine, Hampshire Hills.

230. TALC (*Hydrated Silicate of Magnesia*).

A beautiful snow-white form occurs in the Arthur River near its junction with the Hellyer; on the west branch of the Clayton Rivulet this mineral occurs as a vein of a yellowish-white colour, and is about two feet in width; about one mile north of Remine, on the coast, a beautiful semi-transparent form exists in considerable abundance; it abuts upon the Serpentine outcrop; it varies in colour from translucent white to a clear pale green; a large formation occurs on the Meredith Range, near the Castray River: it is massive, compact in structure, and very pure; the prevailing colour is a beautiful pale sea-green, shining, and extremely unctuous; of sub-crystalline structure in large masses, Magnet Range; in radiating masses with Cassiterite, North Valley, as well as impure and massive at other places at or near Mount Bischoff; Asbestos Mountain, near Beaconsfield; near the Parson's Hood Mountain; Ben Lomond; Blue Tier.

231. TOPAZ (*a Fluo-silicate of Alumina*).

When waterworn this mineral has much the appearance of the more common mineral Quartz, from which it may be known by its greater hardness and rhombic crystallization.

It occurs in this island in pale shades of green and blue to colourless —the yellow, Saxon, and the Brazilian forms are unknown. It is obtained at several localities in profusion, of the "finest water, and of a brilliancy scarcely inferior to that of the Diamond" (Bristow, "Glossary of Mineralogy," 1861, p. 383).

This beautifully brilliant gemstone is unfortunately out of fashion for the jeweller's art, although fifty years ago it was much in vogue. It is found of all sizes; specimens have been obtained measuring nearly eight inches in length and of perfect transparency. At Killicrankie Bay, on the west side of Flinders' Island, it occurs in great profusion both as waterworn pebbles and more rarely in fine well-defined crystal forms in alluvial drift resulting from the detritus of the Granite rock: several other minerals are common with it, including Quartz, Zircon, and Tourmaline. The Topaz is but rarely obtained *in situ*,—it usually occurs in vughs in the Granite associated with crystals of Felspar and Quartz. Gould states (Pro. Royal Soc. Tas., 1871, p. 60), that they originate from bands varying in width from one to several feet, composed of the ordinary ternary Granite minerals highly magnified, the size of the individual minerals being "enormously increased so that the blocks of Felspar, Quartz, and even mica, occur up to several feet in dimension. These appear to be the scene of the most abundant source of the Topazes, which have crystallized out into natural cavities from whence they have been delivered by erosion." At

Mount Cameron they are abundant, although generally much worn; in the stanniferous drift large examples have been frequently met with. They occur more or less abundantly all through the north-eastern Tin-producing districts, Thomas's Plains, Moorina, and the Weld River being noted localities. The Topaz rarely, if ever, occurs on the West or North-western portion of the island, the only form of this substance, so far discovered, being the Topaz-porphyry of Mount Bischoff, which was first recognised and minutely described by the late Professor von Groddeck, of the celebrated School of Mines at Clausthal (Pro. Royal Soc. Tas., 1885), and the cylindrical variety Pycnite, which occurs disseminated in the more abundant Quartz-porphyry of the same locality.

The Topaz-porphyry of Bischoff is usually more or less stanniferous, and is comparatively scarce—the ordinary rock being a Quartz-porphyry, which in general characteristics is allied to a form known as Eurite: it is granular to crystallized in structure, the combined Topaz being pseudomorphous after Quartz; the crystals are usually very minute, and strongly retain the well-known hexagonal form of the parent mineral, but with a milky and less lustrous appearance. The only other recorded locality for this peculiar and interesting form of Topaz-rock is the Tin mines of the Schneckenstein of Saxony. This restricted distribution, structure, and chemical composition, render it of extreme interest to the mineralogist.

I am informed that small specimens of Topaz have been sparsely found in alluvial drift in the vicinity of Mount Claude, but the identification is open to doubt.

232. VIVIANITE (*Phosphate of Iron*).

In groups of crystals which are occasionally nearly half an inch length, from cleavage planes in rock, adit Mount Bischoff; in blue and green amorphous clay-like mass, Waratah River; in crystallized bunches, No. 1 North Pioneer reef, at Waterhouse; as a soft clay more or less impregnated with the phosphate, Supply Creek; of a dark blue colour in fibrous radiating bunches with granular Quartz, Lucy Creek, Pieman River; in large quantity disseminated in decomposing argillaceous shale, North Bischoff.

233. VALENTINITE (?) (*Oxide of Antimony*).

As small white crystals in lode-matter. Hay's Prospecting Association mine, Castray River.

234. VAUQUELINITE (*Chromate of Lead and Copper*).

This is a rare mineral, which hitherto has been considered peculiar to the Silver-lead mining districts of Siberia. The substance as occurring here has a peculiar and unusual siskin-green colour, and is found in an amorphous, somewhat mammillated mass of a dull appearance. Before the blowpipe and in Nitric Acid it gives all the characteristic results. It has been obtained in moderate quantity, with Galena and Arsenical Pyrites, near George's Bay; in minute particles with Crocoisite, Adelaide Proprietary Silver mine, Dundas. This mineral has not been observed on the mainland of Australia.

235. VANADINITE (*Vanadiate of Lead*).

Obtained in extremely limited quantity as small implanted globules and thin incrustations on Siderite, with minute crystals of Galenite and Sphalerite; it is of a reddish-yellow colour normally, but weathers yellow and again fading to a dirty brown. So far it has only been detected at the Bell's Reward Silver mine, Heazlewood.

236. WOLLASTONITE (*Silicate of Calcium*).

A massive white mineral generally obtained in lamellar masses. Mr. W. R. Bell, *in litteris*, states that "the tabular spar at Highwood, south from the Hampshire Hills, merges gradually into a crystalline rock much resembling a variety of Diallage, which is brown in colour."

237. WOLFRAMINE (*Hydrated pure or earthy Tungstic Acid*).

Occurs as pulverulent, earthy, and more rarely semi-crystallized patches and bands of a more or less intense yellow colour. It is commonly adherent to and coating Wolframite, from the decomposition of which it is derived. Ben Lomond.

238. WAVELLITE (*Phosphate of Alumina*).

This is invariably in all known localities a rare and local mineral. It has been discovered in a rock cutting in a greyish-green clay-slate. The mineral occurred in the cleavage planes of the rock in the form of flaky, radiating discs, of a white and glistening appearance, which are usually under a quarter of an inch in diameter. Australasian Slate quarry, Back Creek; on the Forth River, south of the Van Diemen's Land Company's track, in 1864, associated with Galena and Blende (James Smith); at Mount Ramsay, as white circular patches with a strongly radiating structure implanted upon Hornblende; of small size in altered slate at Mount Bischoff. (W. R. Bell).

239. WOLFRAMITE (*Tungstate of Iron*).

Usually occurs in a massive form or in radiating blades penetrating and intermixed in a Quartz gangue. It varies little in colour, being almost invariably of a dark brownish-black, with a submetallic lustre. Recently this mineral has become of considerable commercial importance for the production of Tungstic Acid, which is principally used to give greater hardness to steel and aluminium. It is found associated with Cassiterite in lodes occurring in Granitic rocks. Ben Lomond; Ethel mine, Blue Tier; North Pieman River, near the coast; Gould's Country; Black Bluff Mountain; Mount Thomas, near Mount Claude; Castra, Upper Leven.

Wolfram may be known from Cassiterite by its perfect cleavage, which is a constant character; the latter mineral has always a granular structure.

240. WAD (*an impure mixture of the Oxides of Iron, Manganese, and other elements*).

A common associate of other ores of Manganese, usually occurring in botryoidal masses and bunches. Godkin and Heazlewood Silver-lead mines, Heazlewood; often met with at Dundas and Zeehan.

This is not a species, but simply a mixture of decomposed minerals; when it contains a few per-centum of Cobalt oxide it is termed Asbolite.

241. YTTROCERITE (*Hydrofluoride of Calcium, Yttria, and Cerium*).

An extremely rare mineral, occurring in amorphous masses, which usually have a sub-crystalline to earthy structure. Its only known locality in this island is Mount Ramsay, where, Mr. W. R. Bell informs me, it forms reddish-brown irregular flakes and patches of small size in the Hornblende rock of the locality.

242. ZINCITE (*Oxide of Zinc*).

Found as minute crystals and as small patches on Siderite and Quartz, which are usually aggregated in clusters. The colour is a bright clear red. Heazlewood.

243. ZARATITE (*Carbonate of Nickel*).

This is usually termed "Emerald Nickel" from its beautiful green colour. It occurs in varnish-like coatings on Chromite and Magnetite, upon either of which it is invariably parasitic; at its original locality it sometimes forms mammillary or stalactitic crusts on the same iron minerals. It is mineralogically a rare and local form, its principal and original locality being Texas, Pennsylvania, U.S. America: it occurs in less quantity in Shetland and Spain. It is not known to occur in Australia. In physical character it closely resembles the well known commercial Nickel ores of New Caledonia (Garnierite and Noumeaite), but they are hydrated silicates of Magnesia and Nickel. So far as known Zaratite is not of any economic value, although if discovered in large quantity it could probably be worked with profit.

Heazlewood, on a high hill on the north side of the river, with Serpentine and a small quantity of Pentlandite, The Ballarat School of Mines collection contains a specimen of this mineral marked "Mt. Zeehan, 16/9/92," but I think an error has been made as to locality, for, so far as I am aware, it is restricted to the Heazlewood locality as given.

244. ZIRCON (*Silicate of Zirconia*).

This mineral is isomorphous with Cassiterite. It forms when cut and polished a beautiful gem-stone, for which purpose the Tasmanian specimens are peculiarly adapted on account of their high lustre, in which respect they perhaps excel those from all other localities, although they are not, as a rule, so highly coloured as those obtained in Northern New South Wales and Southern Queensland.

As occurring here they are usually more or less transparent: in colour they vary through many shades of brown to red, and although occasionally fine clear stones of good colour are obtained, they are usually much clouded with darker tints. The Zircon presents three distinct varieties of colour, viz., the Jargoon, yellow-brown; the Hyacinth, bright red; and that termed Zirconite, which is almost opaque and reddish-brown in colour: all three are fairly abundant here. In this island it has not apparently been obtained *in situ*, but doubtless originates from the detritus of the Granite rock. It is abundant in the stanniferous drifts of the North-east coast, where it occurs with Topaz, Pleonaste, and Quartz. Well developed crystals are of extreme rarity, as it is generally much waterworn. The specimens from near Table Cape are, as a rule, darker and brighter in colour than those occurring on the Tin-fields, but they are commonly more fractured, although fairly good crystals are not nearly so rare.

It has been found clear and colourless at the Blythe River; in beautiful glassy and lustrous crystals, ranging from one-eighth of an inch in length to extremely minute, Meredith Range and the North Pieman; in many colours—yellow, green, and red to colourless—Boat Harbour, near Table Cape; in many variations of colour, including bright clear red, Flinders and Long Islands, Bass Straits; in large numbers, often of considerable size, in drift, Moorina, Weld River, Thomas's Plains, and other places on the North-eastern tin-field.

THE GLACIER EPOCH OF AUSTRALASIA.

Review of the Evidences of Former Glaciation in Australasia, with Critical Observations upon the Principal Causal Hypotheses which have been advanced to Account for Glacial Epochs Generally.

By R. M. Johnston, F.L.S.

Read 13th une, 1893.

THE GLACIER EPOCH OF AUSTRALASIA.

CONTENTS.

Introduction :

Evidences of Ice-action derived from the study of existing Glaciers in the Northern Hemisphere.
Evidence of former glacial action—Moraines, roches-moutonneés, scooped or abraded lake-basins, striated rocks and stones, erratics, perched blocks.
Principal evidence of intense glacial action, boulder-till, or *Grund-moraine.*
The glacial "Till" of Scotland.
Inferences from the Glacial phenomena of Scotland.
Evidences of former glaciation in Australia, New Zealand, and Tasmania. New Zealand, Australia.
Apparent absence of glacial deposits corresponding to the "Till" of Scotland.
Evidences of comparitively recent glaciation on the Australian mainland, as recorded by various observers. South Australia.
Evidences of glacial action in the elevated valleys of the Australian Alps.
Doubtful evidence at Korkuperrimal on lowlands.
Evidence of recent glacial action in Tasmania.
Glaciation in the Alpine valleys of the Western Highlands of Tasmania.
Evidence of Glacial Epochs concurring with Great Cycles of change in Organic Life.
Glacial Epochs harmonising with Great Cycles of change in Plant Life.
Evidences of glacial action in rocks of Permo-Carboniferous age. Tasmania, Australia, other Countries.

The causes of Glacial Epochs.
Objections to the Astronomical Theory, taken alone, as an adequate cause of Glacial Epochs.
The weight of negative evidence.
Improbability of finding evidence of intense glaciation in any portion of Australian lowlands among rocks of the same age as the Glacial Epoch of the Northern Hemisphere.
Immunity of Australia due to latitudinal position.
Syria and Arabia, and Northern Africa, the equivalents of Australia in North Latitudes.
Estimated effect on the lowering of the névé at the time of the "Ice Age" in Europe.
Calculations determining, approximately, the altitude of the névé for Australia and Tasmania during the Glacier Epoch of Australia, and the later Glacial Epoch of Europe and North America.
General conclusions.
General References to recent Literature on the subject of glacial action.

INTRODUCTORY.

The study of the geology of the globe we live in presents many fascinating subjects. In its *Cosmical* aspect we may confine ourselves to speculations as to its mode of origin, from nebular matter to the final stages which culminated in its specific differentiation as a subordinate among many other members of the Solar system; in its *Geognosy* we may revel in the nature and complexity of the combinations of elements which constitute its varied rocky materials; in its *Geotectonic* or *Structural* aspect we may enter upon questions relating to the nature of and the manner in which the architecture of the earth's crust has been developed, modified, or transformed; in its *Dynamical* aspects we may inquire into the complex causal forces which are, or have been engaged in producing disturbances, movements, and changes in its physical structure; in its *Stratigraphical* aspect we may devote our attention in tracing the chronological sequence and relationship of the various formations which comprise its visible crust or shell; in its *Physiographical* aspect we may dwell upon its surface feature of mountain, valley, plain, plateau, lake, cañon, river bed, or ocean abyss, and try to understand the causes which have operated in producing its sculptured form; and finally in its *Palæontological* aspect we may trace the history of the organic life forms whose remains are found preserved in the rocks, their succession or evolution, and their relationship to the corresponding succession of rocks. The geological field is thus wide and varied, and we may become so absorbed in the investigation of any one division of the several aspects referred to as to forget the claims and importance of the others. It is well, therefore, from time to time, that we should have our attention aroused to the claims and interests of branches of geological study outside of that to which each of us, respectively, may happen to be too deeply immersed. We therefore cannot realise the benefits of such papers as that of Messrs. T. B. Moore and A. Montgomery, M.A., which arouse us from our own favourite grooves and recall our attention, for a time at least, to that large and important phase of *Dynamical Geology* known as Glacial Action. This phase also at once inevitably leads on to considerations as to its *cause* or *Cosmical aspect*; to its *effects* as in its *Stratigraphical* and *Physiographical* aspects; and to the *period* of its manifestation as in its *Chronological* aspect.

Before we enter upon the question of evidence as to the occurrence of a former climate in Australasia sufficiently intense to be designated "A Glacial Epoch," we must briefly consider the character of the evidence by which we infer its actual occurrence. It is obvious that we cannot directly approach the subject of the earth's temperature at a former period; for the original *cooled* air and the *frozen* water cannot be conceived to be stored up and preserved for observation, as in the case of ancient forms of life preserved in the rocks. But while *directly* we can gain no information as to temperature, we have abundant evidence preserved of the effects, which, according to our present knowledge, can only have been produced by an intensely low temperature acting upon watery vapours while subjected to the universal law of gravitation. It is, therefore, clear that it is in the preserved dynamic effects of moving masses of snow or ice, and, negatively, in the poverty or total absence of life forms that we have the best, if not the only, means of inferring the severity of the climate of a former period.

Evidence of ice action derived mainly from the Study of Glaciation in the Northern Hemisphere.

We have at present in the Alpine regions of Europe, Asia, America, and New Zealand, ample means for determining for various latitudes and for varying levels the peculiar or characteristic effects produced by a long-continued low temperature upon water vapours and upon forms of organic life long exposed to it, and we have also obtained, by the careful researches of many skilled observers, very clear knowledge of the dynamic action upon rocks of the frozen snow and ice in gravitating from the higher to lower levels; of its transporting and abrading power over higher and lower land surfaces, as in boulder-till deposits in *roches-moutonnees*, and scooped lakes; and of its peculiar modes of discharging its load of foreign matter as it melts, as in the terminal and lateral moraines, and perched blocks, at the foot or in slopes of mountain valleys, or in the erratics dropped in the soft bed of lakes, estuaries, or seas, from the melting or overturning of ice sheets or icebergs.

The character of these evidences is in no way affected by considerations as to the primary cause of the lowered temperature, which will be discussed hereafter on its own merits. The evidences, therefore, upon which we must rely, mainly, as proof for inferring the occurrence of a glacial epoch in Australia and Tasmania, may be summarised as follows :—

Evidences of former Glacial Action.

1. TERMINAL MORAINES.

The existence at or near the mouth of the fan-shaped openings of narrow mountain valleys, of mounds, sometimes of great extent, of loose tumbled materials, forming heterogenous masses of rock boulders, shingle, gravel, and other detritus, showing no signs of arrangement in layers or bedding as in detrital distributed by water. The harder rocks are often polished and worn on one side, and frequently exhibit, more or less distinctly, fine lines, scratches, or grooves, which usually run along the surface parallel to the greater axis. Some of the blocks may be many tons in weight. These *moraines* are evidence of the detritus left at the melting extremity of a glacier, or mark the line of its final retreat.

2. LATERAL MORAINES AND PERCHED BLOCKS.

Similar materials found fringing the sides of the higher slopes of a mountain valley, especially large masses of rock (perched blocks), differing in character from the rock slopes or crown above them, may indicate the retreat of a diminishing glacier; but as the greater part of these accumulations often fall eventually to a lower level by gravitation, it would be difficult to distinguish these from accumulations gravitating from higher slopes in the ordinary way. Large foreign erratics, and polished and striated stones, *alone* can be depended upon where such intermixture is possible, as at the foot of all steep mountain slopes.

3. ROCHES-MOUTONNEES, AND ICE SCOOPED LAKE BASINS OR TARNS.

In certain parts of valleys in which the detritus of glaciers occur, the river of ice of great weight, and shod with hardened rocky materials, exerts immense pressure and wears down, polishes, and rounds off the surfaces and edges of such portions of the rocky bed which offer any obstruction to its downward progress. Geikie happily describes the more conspicuous of these rounded polished bosses, exposed after the retirement of a glacier, as "hummocky bosses of rock having smooth, undulating forms like dolphins' backs," and have received the name of *roches-moutonneés*. One of the finest examples of roches-moutonneés in Tasmania observed by the writer in the year 1887 exists on the northern side of Lake Dixon, in the centre of the narrow valley leading down from the ice-scooped lake tarn or basin of Lake Undine, lying at the upper end of this elevated valley (2,300 feet above sea level). Lake Dixon itself, and several tarns with islets near to it, have all the appearance of ice-scooped basins.

4. STRIATED AND POLISHED SIDES OF PRECIPITOUS ROCKS ALONG THE COURSE OF A GLACIAL STREAM AND STRIATED BLOCKS AND STONES OF MORAINES.

The stones carried on the surface of a glacier often fall through crevices to its lower surface, or are jammed in between the mural edge of the moving ice and the precipitous sides of rock along its course, and thus act and are acted upon, producing polished, scratched, and grooved surfaces. The fixed rock surface markings of striæ, lines, and grooves record the prevailing direction of the ice stream, while the striated boulders and rocks of the moraines afford guidance as to the ultimate source from which they have been derived.

5. ERRATICS, BOULDERS, AND FOREIGN ROCK DEBRIS, DROPPED IN LAKE OR SEA BOTTOMS FROM FLOATING ICE.

Foreign rocks, both angular and waterworn, may be drifted for long distances upon lakes, estuaries, and seas by three distinct agencies.

The roots of fallen trees of great size may be drifted to great distances by rivers and estuaries currents, and may transport bound up in the ramifying branches of roots large quantities of clay and stones, which are eventually dropped and scattered as foreign bodies among the ordinary sediments and organisms of estuaries or seas.

The clasping roots of giant forms of kelp and other marine sea-weed may, when storm-tossed, drag and transport for a distance the stones upon which they originally grew. These stones are generally polished and waterworn, are of moderate size, and show no sign of striæ.

The only known agents, however, which are capable of floating and transporting to great distances rocks and boulders of great mass and weight are *floating masses of ice*. Glaciers which descend into the sea break off in huge masses, as icebergs or ice sheets, and carry their burden of moraine stuff, which often include masses of rock of enormous weight, until the mass of ice melts or is overturned, when the rocks are discharged and fall to the quiet sea bottom as *erratics*.

Shore ice of Arctic regions when breaking up may, in a similar way, transport and discharge erratic boulders over the sea bottom.

PRINCIPAL EVIDENCE OF INTENSE GLACIAL ACTION.

In regions, or at periods when the climate was refrigerated sufficiently to cause permanent snowfields on the tops of the higher plateaux of mountains, and merely caused glaciers to form in the sub-alpine valleys which melted before reaching the lowlands, the evidences of ice action are confined to those indicative of milder glacial effects, viz., lateral and terminal moraines in the higher valleys, perched blocks, roches-moutonneés, scooped lake basins, striated, polished, and grooved rocks and boulders, lines of striation of fixed rocks running in harmony with the direction of the particular valleys in which such marks occur. But when refrigeration of climate becomes as intense as in the pleistocene glacial epoch of Northern Europe and America, which covered all the surface of the land, save the highest peaks of mountains in these regions; when glacial ice sheets—no longer mere ice rivers confined within mountain valleys—spread, as in polar lands, in devastating "*seas of ice*" across the whole land and intervening lakes and seas, the action of the travelling sea of ice produces effects of quite a distinctive character from the limited drums and longitudinal heaps of moraine stuff of mere upland *ice rivers*.

The detrital matter of wide-spreading ice sheets, in moving slowly over the irregular surface of the lowlands of a country, is best described by reference to the character of what is now known to be partly the produce and partly the form of redistribution of superficial materials, as seen in the so-called till or boulder clay of Scotland.

The character and derivation of the "till" formed by the intense glacial action of the great land ice sheet in Scotland is graphically described by Wallace in his "Island Life" (pp. 109-112), whose views are in accordance with those so ably advocated by Professor Jas. Geikie in his well-known work, "The Great Ice Age."

The Glacial "Till" of Scotland.—Dr. Wallace writes:—"Over almost all the lowlands, and in most of the Highland valleys of Scotland, there are immense superficial deposits of clay, sand, gravel, or drift which can be traced more or less directly to glacial action. Some of these are moraine matter, others are lacristrine deposits, while others again have been formed or modified by the sea during periods of submergence. But below them all, and often resting directly on the rock surface, there are extensive layers of a very tough, clayey deposit known as the 'till.' The till is very fine in texture, very tenacious, and often of a rock-like hardness. It is always full of stones, all of which are of rude form, but with the angles rubbed off, and almost always covered with scratches and striæ, often crossing each other in various directions. Sometimes the stones are so numerous that there seems to be only just enough clay to unite them into a solid mass; and they are of all sizes, from mere grit up to rocks many feet in diameter. The 'till' is found chiefly in the low-lying districts, where it covers extensive areas sometimes to a depth of a hundred feet, while in the Highlands it occurs in much smaller patches, but in some of the broader valleys forms terraces which have been cut through by the streams. Occasionally it is found as high as two thousand feet above the sea, in hollows or hill sides, where it seems to have been protected from denudation." The "till" is totally unstratified, and the rock surfaces upon which it almost always rests are invariably worn smooth, and much grooved and striated when the rock is hard, but when it is soft or jointed it frequently shows a greatly broken surface. Its colour and texture, and the nature of the stones it contains, all correspond to the character of the rock of the district where it occurs, so that it is clearly a local formation. It is often found underneath moraines, drift, and other late glacial deposits, but never overlies them (except in special cases to be hereafter referred to), so that it is certainly an earlier deposit. Throughout Scotland where "till" is found the glacial striæ perched blocks, *roches moutonneés*, and other marks of glacial action occur very high up the mountains to at least 3,000 and often 3,500 feet above the sea, while all lower hills and mountains are rounded and grooved on their very summits, and these grooves always radiate outwards from the highest peaks and ridges towards the valleys or the sea.

"*Inferences from the Glacial Phenomena of Scotland.*—Now all these phenomena taken together render it certain that the whole of Scotland was once buried in a large sea of ice, out of which only the highest mountains raised their summits." "The weight of this vast ice sheet, at least three thousand feet in maximum thickness, and continually moving seaward with a slow grinding motion like that of existing glaciers, must have ground the whole surface of the country, especially all the prominences. leaving the rounded rocks, as well as the striæ we still see marking the direction of its motion. . . The present glaciers of the Alps being confined to valleys which carry off a large quantity of drainage water lose this mud *(sticky, tenacious clay)* perhaps as rapidly as it is formed ; but when the ice covered the whole country there was comparatively little drainage water, and thus the mud and stones collected in vast compact masses in all the hollows, and especially in the lower flat valleys, so that when the ice retreated, the whole country was more or less covered with it. It was then, no doubt, rapidly denuded by rains and rivers, but, as we have seen, vast quantities remain to the present day to tell the tale of its wonderful formation. There is good evidence that when the ice was its maximum it extended not only over the land but far out to sea, covering all the Scottish islands, and stretching in one connected sheet to Ireland and Wales, where all the evidences of glaciation are as well marked as in Scotland, though the ice did not of course attain quite so great a thickness." "That the ice sheet was continuous from Scotland to Ireland is proved by the glacial phenomena in the Isle of Man, where 'till' similar to that of Scotland abounds, and rocks are found in it which must have come from Cumberland and Scotland, as well as from the north of Ireland. This would show that glaciers from each of these districts reached the Isle of Man, where they met and flowed southwards down the Irish Sea. Ice marks are traced over the tops of mountains which are nearly 2,000 feet high." Dr. Wallace concludes with the statement that "It is evident that the change of climate requisite to produce such marvellous effects in the British Isles could not have been local, and we accordingly find strikingly similar proof that Scandinavia and all Northern Europe have also been covered with a huge ice sheet. In North America the marks of glaciation are even more striking than in Europe, stretching over the whole of Canada, and to the south of the Great Lakes as far as latitude 39°. There is in all these countries a widespread deposit, like the 'till' of Scotland, produced by the grinding of the great ice sheet when it was at its maximum thickness; and also extensive beds of moraine matter, true moraines and travelled blocks left by glaciers as they retreated towards the mountains, and finally withdrew into the upland valleys." After combating objections, he concludes thus:—"There is perhaps no great conclusion in any science which rests upon a surer foundation than this; and if we are guided by our reason at all in deducing the unknown from the known, the past from the present, we cannot refuse to assent to the reality of the glacial epoch of the Northern Hemisphere in all its more important features."

EVIDENCES OF FORMER GLACIATION IN THE SOUTHERN HEMISPHERE (AUSTRALIA, NEW ZEALAND, AND TASMANIA) SUBSEQUENT TO THE DEPOSITION OF ROCKS OF MIOCENE AGE.

New Zealand.—One of the most accomplished geological observers, Prof. T. D. Hutton, in commenting "On the Supposed Glacial Epoch in Australia" (Proc. Roy. Soc. of N.S. Wales, pp. 338, 339, 1885), states that "In New Zealand there are, as is well known, ice marks dating from the present day to some period when the glaciers were at their greatest extent, and for many years New Zealand geologists have been accustomed to call this latter time the *glacier* epoch of New Zealand, in order to distinguish it from a *glacial* epoch, which term implies a considerable reduction of temperature." The term *glacier* he considers does not imply any hypothesis as to the cause. He affirms also that all New Zealand geologists are of opinion that the *glacier* epoch there was long anterior to the glacial epoch of Europe and North America. In combating erroneous views of Dr. von Lendenfeld as to the date of the former glacier epoch, he states that "The islands in the Sounds are not *moutonneés*, and although some of the smaller ones are rounded, they show no signs of lee and strike sides, The precipices on either side of the Sounds are also in general quite rough, and I noticed only two localities (both previously observed by Dr. Hector) where there was any appearance of polishing: one was in Milford Sound on the south side of the entrance to the "Narrows,' the other near Deas Cove, in Thompson Sound. I saw neither grooves nor striæ; but Dr. Hector noticed them in Thompson Sound, and in the Cleddan Valley." He, however, continues:—"All this is very different from any glaciated district in Scotland, Wales, or Ireland, where nearly every rock tells the same tale, and, judging from published accounts, it is very different from the fiords of Norway, the rocks of which are much the same as those of the West Coast Sounds of New Zealand. Yet that these Sounds have at one time been occupied by ice is proved by the huge granite boulders lying on the sandstones and mudstones at Kisbee Bay in Preservation Inlet." He refers these evidences of glaciation and great glacier epoch as belonging to a very ancient date, long anterior to the glacial epoch of Europe and North America. There is apparently nowhere in New Zealand any evidence of such intense glaciation as that which spread over the lower levels of Scotland, Ireland, and Wales, as we have no mention of anything corresponding to the "till" of the great northern ice sheet.

The absence of such evidence in a region whose mountains rise to a height of over 12,000 feet,* and whose southern borders extend to 47° 10' south latitude, is full of significance when we come to consider the various theories advanced to account for the occurrence of the great glacial epoch in the Northern Hemisphere, and especially so when we come to examine the proofs of a true glacial epoch in the more northerly limits of the Australian mainland.

Australia.—In the Australian mainland there are no high mountains as in New Zealand. The highest peak in the eastern cordillera occurs in the southern and eastern Australian Alps in about 37°, corresponding to the position of Mount Etna in north latitude—Mount Kosciusko and Mount Townsend, the two highest peaks attain here an elevation of 7,171 and 7,256 feet respectively. The whole of the mainland lies within 11° and 39° south latitude, broadly corresponding to the position of Northern Africa or Syria and Arabia in northern latitudes. As moreover the greater portion of Australia is low-lying, it can be no more expected that we should find any traces of intense glacial action within its borders in past times, than that we should look for evidences of the extension of the great ice sheet of Northern Europe in the lowlands of the lower northern latitudes of Syria and Arabia.

Apparent Absence of Glacial Deposits corresponding to the "Till" of Scotland.—Setting aside for the present the origin of certain erratic boulders and other marks of glaciation which are found in beds of conglomerate in New South Wales, Victoria, and Tasmania, in rocks corresponding to the close of the Permo-Carboniferous age, and which undoubtedly appear to have been transported to their present position by means of floating ice—no satisfactory evidence of glacial action has yet been discovered in Australia corresponding to the till, boulder clay, *moraine-profonde or grund-moraine* of the great ice age of Northern Europe and North America. Indeed it would be a matter of the greatest surprise, even to the most ardent disciples of ice-cap extension, in Europe and America, if such evidences should appear; for neither the advocates of the effects upon climate of the extremes of eccentricity of the earth's orbit combined with the precession of the equinoxes, the advocates of changes in the distribution of land and water, nor the advocates of a combination of astronomical and geographical causes, have ever attempted to show that influences could possibly induce such an extreme lowering of temperature as would cause the northern polar ice cap to creep and extend beyond the north latitude of 39°, which point corresponds in south latitude nearly with the

*Mount Cook 12,349 feet.

most southerly limits of the low-lying Australian Continent. In Western Europe, during the great ice age, there is no evidence of the great ice sheet extending further south than 51° north latitude. When we consider that the most southerly point of Australia corresponds with Lisbon in north latitude, or 12° to the south of Ireland, we may more readily comprehend the improbability of an extension of the southern polar cap to any part of the Australian Continent under similar conditions to those of the European ice age.

Evidences of comparatively recent Glaciation on the Australian Mainland, as Recorded by Various Observers.—Subsequent to the earlier observations of Selwyn, Daintree, and others in respect of ancient glacial phenomena in rocks of Permo-Carboniferous age, it would appear that Professor Tate, in the year 1877, was the next observer who drew particular attention to the existence of glacial phenomena on the mainland of Australia of a comparatively recent date. In a paper of a later date, read before the Australasian Association for the Advancement of Science (Proc. 1887, pp. 231, 232), entitled "Glacial Phenomena in South Australia," he again describes the nature of the evidence upon which he bases his conclusion as to their glacial origin. He describes the glaciated surface as well developed on the coast cliffs at Hallet's Cove, south of Holdfast Bay, in St. Vincent Gulf. That is, therefore, in 35° south lat.; and, as the surface plane of the track inferred to have been polished by the ice is now only 40 feet above the level of the adjacent sea, it is more than probable that the track was marked prior to the final stage of the known upheaval of the floor of the old tertiary sea, whose remains in the vicinity, and as cliffs along the Great Australian Bight, form the most characteristic feature of the South Australian coast line. Professor Tate states that "The path of the glacier (?) is traceable for a distance of two miles along the top of the scarped cliffs, at about forty feet above the sea level; on the north it is cut off from the cliff by encroachment of the sea, from this point the glaciated surface is continuous in a southerly direction for a distance of one mile to Black Point, the north headland of Hallet's Cove. On the line of the glacier there now intervenes the long but narrow bay of Hallet's Cove, but on the south headland the track is picked up on about the same trend, though apparently at a little higher level. Here again the glacier (?) path is soon cut out by removal of the cliff. On the north side of the cove the glaciated surface is beautifully displayed; the edges of nearly vertical strata are sheared off, and when of quartzite the surface shows a high polish, and when of mudstones, conspicuous grooved and striæ. Some moraine *debris*, including stones that have been beneath the glacier (?) occur here. On the south side moraine matter is very abundant, and includes many boulders, some occurring as *blocks perches*."

"The common rocks of the moraine *débris* are granites, gneiss, hornblende schists, and others, which do not occur in situations nearer than the Gorge at Normanville, about 46 miles to the south. In all, 17 distinct varieties of rock, chiefly metamorphic and foreign to the immediate neighbourhood, have been collected along the path of the glacier. The proximity of the miocene escarpments suggest the possibility of the pre-miocene (post-miocene?) age of the glacier." . . . "It is highly probable that the glacier cut its way through the incoherent miocene formation, and that some of the miocene shingle furnished some portion of the moraine *debris*."

Professor Tate selects particular examples of the *debris* for illustrating their glacial character, viz, slab of quartzite having a highly polished surface and faintly striated; chip of mudstone having a smooth surface, strongly striated and grooved; ice-worn pebble polished and striated on its upper and lower faces, found partly embedded in soil resting on glaciated surface. Professor Tate also draws attention to some forgotten early observations of Mr. Selwyn in relation to glacial phenomena in South Australia, discovered, by him, further south in the bed of the Inman, Cape Jarvis Peninsula, consisting of smooth striated and grooved rock surfaces, of which Mr. Selwyn wrote:—"The direction of the grooves and scratches is east and west in parallel lines, and though they follow the course of the stream I do not think that they could have been produced by the action of water forcing pebbles and boulders detached from the drift along the stream." The rounded surfaces of mica slate on the south flank of Kaiserstuhl and Crafer's on the Adelaide chain referred to by Professor Tate are less satisfactory, and are only suggestive, and their value as collateral supports depends entirely upon the character and derivation of the ice which caused the phenomena near the present sea level at Black Point, Holdfast Bay. Professor Tate's own conclusions as to the cause of these undoubted glacial phenomena are threefold, viz., either—

1. The prevalence of a very much colder climate.
2. That the land stood at a much greater altitude (say 10,000 feet), or the mountains (presumably the Adelaide chain, whose few high peaks at present do not much exceed 2,000 feet, R.M.J.) may have had a more plateau-like form, and therefore need not have been so high, and consequently collected more snow.
3. A combination of both of the preceding conditions (1 and 2).

There is another condition, however, which Dr. von Lendenfeld* and others favoured, which also embraces Professor Tate's first condition—much colder climate—as a contributing cause, viz., the grinding action of partly stranded sheets of the Antarctic drift ice, whose extreme northerly limits, even in the present mild epoch, ascend almost into the same degree of south latitude in the vicinity of the Cape of Good Hope. But Professor Hutton points out that the existence of granite in the south polar region has not yet been discovered. All the land at present known is volcanic. It is suggested, however, that Tasmania and New Zealand could furnish such materials, but it is improbable that the well-known glaciers of the western highlands of Tasmania descended to sea level.

It is almost certain, however, that at the last great period of eccentricity of the earth's orbit with winter in aphelion, the limit of Antarctic drift ice would touch the southern extremity of the Australian mainland when Tasmania would stand well within it. It is not improbable, therefore, that in the extreme of winter portions of the drift ice might for a time be stranded on the precipitous shores of Tasmania and New Zealand, or even on the south-western shores of Western Australia, long enough to receive from overhanging cliff or pebbly beach *debris* which, on breaking away in the extremely hot and short summer, might find its way northward, to be again partly stranded on projecting points of the Australian mainland in St. Vincent Gulf, and there to leave in its trail the channelled traces of its course and part of its *debris* picked up on the coasts further south. To my mind this is the only reasonable interpretation which would sufficiently account for all the *verified data* so clearly brought forward to our notice by my distinguished friend, Professor Tate.

The curved form of the encroachment of the sea in the Great Australian Bight also favours the idea that the well-known Antarctic drift current might have operated more powerfully in the last glacial epoch in contributing to the waste action which has determined its present deep bay-like indentation.

It is evident that Professor Tate, who invariably uses the word *glacier*, inclines to the view that the *debris* on the shore of Black Point has been carried down by an inland glacier descending from local mountain tablelands—now only reaching a height of about 2,300 feet—which he assumes, without satisfactory evidence, to have stood 10,000 feet higher since the close of the miocene period, and he further objects to the floating ice theory, because he thinks it involves the necessity of assuming the *submergence* of southern parts of the South Australian province by as much as 1,000 feet, and of this submergence he rightly adds, "That the known facts do not warrant such assumption." But is there any necessity that the advocates of the hypothesis of "floating ice" as the agent of abrasion and transport should assume any *depression* whatever? On the contrary, it seems to me that an *elevation* of, say, 70 to 100 feet of the old sea-bed at the time of glaciation would answer all the conditions which the phenomena of glaciation and present elevation (40 feet above present sea level) demands; and this would allow a depth of from five to ten fathoms of sea over the channel along whose course the glacial phenomena have been traced. It would, in the latitude of St. Vincent Gulf (35° S. latitude), require an elevation of the whole land to a height of 12,000 to 14,000 feet, with a subsequent final depression of about from 11,600 to 13,600 feet to account reasonably for the present level of the glacial phenomena at Black Point, and for the present altitude of the higher members of the old tertiary marine beds; and this double assumption is of a far more serious character, and is far less warranted by known facts than the submergence of 1,000 feet, for which, also, there is not the slightest necessity for assuming, unless it be also insisted upon that the very doubtful appearances of glaciated surface on the heights of the Adelaide range are also to be explained as having been caused by the same agency which produced the glacial phenomena. Notwithstanding my very high appreciation of the judgment of Professor Tate, better evidence than has yet been produced will be required before such a conclusion can be satisfactorily established.

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* Proc. Linn. Soc., N.S.W., 1886.

Until such evidence is produced, I shall be inclined to favour the hypothesis of "partly stranded polar drift ice," carrying *debris* in summer from neighbouring southern shores, not necessarily polar, where the ice drift may have been stranded for some time during the long severe winter. The period when such action took place is likely to have been at a time when the eccentricity of the earth's orbit combined with winter in aphelion attained its greatest limit subsequent to the deposition of the rocks of miocene age. According to Dr. Croll's published tables showing the varying amounts of eccentricity for three million years back, it would appear that the periods of high eccentricity have been exceedingly numerous in that time, and one or two of them far higher than that which is supposed to have been the principal cause of the great glacial epoch of Europe and North America in the pleistocene period.

Now most of the Australian geologists incline to believe that the period of greatest glacial action in Australasia occurred long anterior to that known as the glacial period of Europe. And it is not without significance as bearing upon this question, and also upon the disputed question as to whether the extreme effects of glaciation could, at any time, have been produced by astronomical causes alone (*i.e.*, without the concurrence of favouring geographical causes), to find that the highest eccentricity occurred, according to Croll, 850,000 years ago, at which time the difference between the sun's distance at *aphelion* and *perihelion* was thirteen and a half millions of miles, whereas during the last glacial period of Europe and North America in the Northern Hemisphere, the maximum difference was ten and a half millions of miles only—that is three million miles or 22·22 per cent. less. As from the nature of the distribution of land and water in the Southern Hemisphere, it is probable that geographical causes would not play so important a part in barring the introduction of warm equatorial currents from the hemisphere specially affected; it is also probable that the alteration in climate in the Southern Hemisphere would be almost purely the result of *astronomical causes alone*. If we admit this, we should seek for the cause of the milder *glacier* period of Australasia since the cretaceous age, at that point of time when the eccentricity of the earth's orbit was at its highest, and that was about 850,000 years ago, or fully 550,000 years anterior to the time of the great glacial epoch of Europe in the pleistocene age. This happily corresponds very closely with estimates as to the period which closes the miocene age, at which time there is evidence that the glacier period of Australasia began to mark its effects on our rocks and upon the organic life associated with them.

Evidence of Glacial Action in the Elevated Valleys of the Australian Alps.—In the year 1885 Dr. von Lendenfeld (Proc. Lin. Soc. of N. S. Wales, pp. 44-53) in a paper, entitled "The Glacial Period in Australia," gives an account of glacial phenomena discovered by him in the ascent of Mount Kosciusko, the highest elevation of the Australian Alps (7,200 feet), situated in about south lat. 36° 40' long. 148° east, near the south-eastern border of N. S. Wales. On the southern slope it is drained by the head waters of the Snowy River, while its northern slope is drained by the head waters of the River Murray. The marks of glaciation discovered by Dr. Lendenfeld occur principally in the Wilkinson Valley, at elevations nowhere below 5,800 feet above sea level. These consist entirely of smoothed and rounded surfaces, whose grooves and scratches are supposed to have been removed by weathering, but yielding, as Dr. Lendenfeld states, to an eye experienced in reading the signs of glacier action indubitable proof of having been originally polished and rounded by ice. He states that "One of these instances, on a spur high above a tributary to the Snowy River, was so remarkable that my assistant (*sic*), who had never seen any roches-moutonneés in his life before, was immediately much struck by its appearance. There, there is one rock polished off with a surface of about 3 acres, and about 25 other much smaller ones around it, all polished down to exactly the same surface, divided from one another, however, by depressions of varying depth." He also states that on a spur descending from the Abbot Range *roches-moutonneés* similar in character are very numerous. He did not observe any signs corresponding to perched blocks, moraine stuff, nor *actual* traces of striated or grooved surfaces anywhere, although he conjectures, as regards the possibility of glacial action being traced at levels below 5,800 feet, beneath which he was unable to find further signs, he states:—"I have looked carefully around on my way up and down the mountain, but I was not able to detect any glacial action below 5,800 feet." He, however, is of opinion that in the Snowy valley a glacier might be expected to have descended for some distance from the mountains, and thought it likely that moraines may eventually be found there; but he also adds that it is only in this valley where moraines may be expected, "because it is the only one which comes down from an extensive plateau on which a glacier was formed."

Dr. von Lendenfeld refers the age during which such glacial action occurred to the period which marked the more intense form of glaciation in New Zealand. Mr. Jas. Stirling has also written two or three most interesting papers, in which he gives us the results of careful observations made by him on several occasions among the Australian Alps.

Mr. Stirling corroborates Dr. von Lendenfeld in attributing the polished rock surfaces on Mount Kosciusko to comparatively recent glacial action. He also states that, in his opinion, the observed widespread dispersion of the boulder deposits, the rounded contours of the crystalline rocks, and the undulatory outlines of the foot-hills in many valleys, all bespeak agencies distinct from ordinary fluviatile action, and point very distinctly to glacier action. He further cites additional evidence of glaciation as follows:—"Erratics in the Mitta Mitta and the Kiewa Valleys; huge blocks weighing many tons; smooth surfaces on the Cobberas Mountains and Mount Bogong; moraines at the base of the latter on the Mountain Creek Valley; eroded lake basins, Dry Hill, Hermongee Swamp; Omeo Lake basin; Morainic Lake, Mount Wellington, etc.; but he carefully observes, in conclusion, that "although the *fact* of a glacier action can . . . be satisfactorily established in the Australian Alps, yet further evidence is desirable as to the synchronism of the glacier period in Australia with that of the glacial epoch in the Northern Hemisphere."

So far as the higher levels of the alpine regions of Australia are concerned, the observations of Dr. von Lendenfeld, Mr. Stirling, and other observers leave us in little doubt as to the genuineness of the evidences of glacial action, and of their occurrence at a comparatively recent date; although there is no proof of the date of the occurrence as being coincidental with the glacial period of Northern Europe. Nor is there here any evidence which compel us to infer such refrigeration of climate as would in such a low latitude (36° 40') cause glaciers to descend below the 2,000 feet level above the sea. It is true that certain conglomerates bearing the marks of ice action have recently been discovered in Victoria by Messrs. Graham, Officer, and Lewis Balfour as low as 750 feet above sea level, but these undoubtedly striated boulders, apart from other objections, are so similar in character and so intimately associated in regions of recent igneous disturbance with the well-known glaciated conglomerates of Permo-Carboniferous age, which will be referred to hereafter, that I cannot at present see my way clear to accept the conclusions of Messrs. Officer and Balfour, who recognise some of the deposits as a true boulder "till," or *moraine-profonde*, formed by severe glacial action during "eocene times," and inferred by them to be quite distinct from the earlier glacial deposits associated with them of Permo-Carboniferous age, and from the ice erratics and moraines of the Australian Alps, which they ascribe to a mild glacial period during the pleistocene age. I freely admit that the appearance of some of the deposits so lucidly and ably described by Messrs. Officer and Balfour, especially the deposits on the Korkuperrimal (fig. 3) seem to justify the conclusions arrived at by them; but, what about the similarity of the striated and polished blocks and stones so huddled together in dislocations or fractures of the underlying sandstone to the adjacent and almost contiguous to the ice-borne conglomerates of permo-carboniferous age; the "pell-mell accumulation" of angular and rounded block; the broken and disintegrated clays or shales; the "angular blocks of sandstone in every conceivable position"; the underlying "broken and shattered sandstones"; and the association with the more recently erupted basaltic sheet?

Do not these cumulative evidences, taken together with the latitude and low altitude, rather tend to prove that the rocks, including the older glacial conglomerates immediately underlying the basaltic sheet, have been broken up, dislocated, and jumbled together by the eruptive forces which more recently ejected the overlying basalt?

Surely this seems to be the more reasonable inference in accounting for the so-called boulder "till." Why, in the pell-mell ruin of the older sandstones, shales, and Permo-Carboniferous conglomerates should we omit to look for the broken remains of the latter conglomerates as well as for the broken remains of the similarly disturbed sandstones and shales? And if the supposed "till" does not contain the fragmentary remains of the admittedly associated older conglomerates of Permo-Carboniferous age, in respect of which we have already ample evidence, as being composed of such polished and striated blocks as are found in the "till,"—What have become of them? The causes which broke up and huddled the older sandstones and shales must have also broken up and jumbled afresh the older associated conglomerates; and it appears to me unreasonable, to suggest the intense glaciation involved in a glacial "till" theory for the origin of the later conglomeration, while the remains of the older and similar conglomerates—so intimately associated over a wide area with the sandstones and shales—have not been satisfactorily accounted for.

Apart from these objections, even the most ardent advocates of the powerful dynamic agency of moving ice are now beginning to recognise that, while influenced by gravitation on steep slopes, the abrading power of ice may have a wonderful grinding action; but they are far from satisfied in regard to its power to tear up, dislocate, and fracture the underlying harder rocks over which it glides, at least not to any great extent. The dislocations and fractures of the underlying rocks at Korkuperrimal, on the evidence given, do not appear to me to be the work of ice.

It is not improbable also, as regards some of the examples, that on abruptly sloping sides of creeks, the gravitating value of older conglomerates, which may have been suddenly thrust up by recent dislocations, may now partly overlie the original deposits of undisturbed older conglomerate at a lower level in their immediate vicinity. Such occurrences are common in Tasmania, where the stratified rocks of Permo-Carboniferous and Mesozoic are frequently faulted and disturbed by the forces which ejected the more recent diabasic greenstones which ramify everywhere throughout these rocks in Eastern Tasmania.

In any case, a preconception in favour of a particular hypothesis is apt to play the same tricks with the scientific imagination as it does with the imagination of unscientific sentimentalists; and in no part of a careful observer's duty is it more imperative that he should guard himself by careful measurement of the "personal equation of error," whether due to enthusiasm or preconception, than in cases where the imagination is apt to read or project hidden foregone causal conclusions or anticipations into those facts of evidence, which, taken by themselves, are readily adaptable to any one of many possible interpretations. There is no field of geological observation where there is more avidity shown in drawing hasty inferences, and forming generalisations from imperfect data, than in that section which concerns itself with the occurrence, dynamical effects, and hypotheses of causation, in respect of former glacial action. In no field is there such assurance expressed, based upon partial or imperfect data, and in the face of the widest divergence of opinion in the interpretation of the same facts. Where sympathies are too strongly enlisted on behalf of a glacial or any other theory, they are apt to disarm the true critical faculty of the observer. He is apt to infer, too readily, that all rounded bosses and smoothed rock surfaces in the vicinity of old shingle beds are veritable *roches-moutonnées*, and that all shingle beds are *moraines*; and under this preconception he is sometimes not critical enough to distinguish the difference between the unequal wearing away of the laminations of polished stones derived from schistose rocks and the veritable *striæ* of ice action.

He is apt to magnify one of the elements which, with other links, are necessary to form the complete chain of proof—as itself the *only* element which may constitute *proof* in favour of a conclusion. As evidence of this partiality, we sometimes hear of the discovery of a single *striated stone* put forward as constituting the only *real proof* of the occurrence of former glacial action. Yet the occurrence of huge perched blocks or erratics, many tons in weight, of a rock foreign to the immediate neighbourhood, resting on a recent accumulation of a well-known rock—loam, clay, gravel, or peat—although now devoid of either polished surfaces, scratches, or grooves, may, of itself, afford more unmistakable evidence in proof of ice action of a certain age, that any number of polished, striated and grooved stones, taken from a tumbled drum of waterworn stones and clay; for the present accumulation in which the striated stones occur may not have been formed by ice action, although some of its contents may have been *derived*, immediately, from former moraine stuff; and even should the striated and polished blocks be now found in a veritable *moraine*, they do not form absolute proof that the ice markings, or at least all of them, were actually caused by the glacier which formed the moraine in which they are now found; for in many of the Scotch fiords or sea-loch basins—if we accept the theory of an inter-glacial period—we must be prepared to find that the older moraines, in the path of the descent of the more recent glacier, would partly be dispersed, while some of its contents might be picked up, and eventually form part of the latter moraines of such districts. Thus, in respect of undoubted ice striated blocks, we must in some cases be prepared to find them as not indicating with certainty the mode of origin of the deposit in which they are now found; but, like certain fossiliferous rocks, they may have been *derived* from an older formation.

An enthusiast is also apt to attribute *all* lake basins as due to the action of glaciers, and is tempted to confound the *debris* of rocks adjacent to steep slopes of mountain due to gravitation, with superficially similar remains left in such a situation (lateral moraines) by the retreat of an ancient glacier. Of course, a typical geological sceptic may, from prejudice, err as widely in the opposite direction, and remain stubbornly unconvinced in the face of the most conclusive evidence. But, in the latter case, although the individual may injure himself, his very stubbornness may benefit geological science in causing search to be made for still more perfect evidence, and in causing the evidences already in our possession to be submitted to still more careful sifting and weighing. I have been led to make these remarks, certainly not as a reflection upon the judgment or conclusions drawn by any of the very able observers commented upon in this review, but rather as my humble apology for venturing to criticise, generally, the opinions of men of better general qualification than myself, in respect of doubtful matters where independent judgment may, without either humiliation or presumption, arrive at very different interpretations with respect to the same facts. These remarks, moreover, apply as strongly to myself in respect of the contributions, for which I am responsible, regarding the evidences in favour of glaciation in Tasmania at two widely separated periods in the history of our rocks.

EVIDENCE OF RECENT GLACIAL ACTION IN TASMANIA.

Mr. Charles Gould, formerly the Government Geologist of Tasmania, was the first person who appears to have drawn attention to the abundant evidence of glacial action in the alpine valleys of Western Tasmania. His geological observations in these regions about 40 years ago, amid great hardships and privations, extended over a period long enough to enable him to work up the topography and to map the characteristic rocks of a very large portion of what has been, until recently, a comparatively unknown and almost inaccessible region. He has left no special memoir on the evidences of glaciation, but it was through verbal communication to a personal friend of my own,* and one of his early associates, that I first, about 20 years ago, became aware of his discovery of many evidences of glaciation in Tasmania, especially in the valleys of the western highlands, which trend westward from the great elevated plateau of 4,000 to 5,000 feet level, which occupies an area of some 400 square miles in the centre of our heart-shaped island. On its northern and western sides this elevated plateau rests upon a less elevated but still more extended plateau, whose undulations preserve a general level of from 2,000 to 3,000 feet above the sea. The extreme western and southern part of the island presents a wild and broken array of lofty mountain ranges and isolated peaks, with deeply cut ravines and valleys, but whose bases rest generally upon lower levels than the western portion of the massive central plateau. Although Tasmania does not possess any mountains of great altitude, its mountainous character may be best realised when we consider that within its limited extent (26,215 square miles) there are 20 names of mountains over 4,000 feet in height, and as many as 50 named mountains whose heights exceed 2,500 feet.

The large inland plateau which maintains a general altitude of about 4,000 feet, rising at times to over 5,000 feet, is worthy of special attention when regarding the conditions necessary for the development of a sufficiently large permanent snowfield, which would suffice to feed glaciers flowing from its marginal slopes, during a period of extremely low temperature; for great height or extremely low temperature, *per se*, does not constitute all the necessary conditions for the development of glaciers.

We must also conjoin with either of these conditions breadth of area of the névé or snow catchment, and a great local precipitation of water vapour. The necessary combinations of these requisite conditions are not dreamt of by many who too readily invoke glacial action within the Tertiary or Pleistocene period in regions where it is difficult to realise the full combination of the essential conditions necessary for its production.

The following description, already given by me in a former publication,† may help to afford the necessary information to those who may wish to know whether, in the event of a greatly lowered temperature, due to astronomical or other causes, the great inland plateau of Tasmania possesses all the other requisite conditions for the generation of glaciers:—

"The great central greenstone plateau of the Lake Country

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* The Hon. Jas. Reid Scott, formerly Chief Secretary of Tasmania.

†Geology of Tasmania, p. 101.

(42° South lat.*), in its northern part especially, preserves a general rugged or undulating level of about 4,000 feet altitude, and its higher bosses and peaks and its valleys do not vary much more than 1,000 feet above or below this uniform level. From the Picton to Gad's Hill, a distance northerly of over a hundred miles, its westerly limit may be roughly traced, forming a bold and widely undulating margin relative to the western country, whose immediate general upland surface ranges between 2,000 and 3,000 feet above sea level. This margin is markedly broken by the elevated outlying spur forming the Eldon Range, near Lake St. Clair. From Gad's Hill in a south easterly direction to the Table Mountain; a distance of not less than 90 miles, its similarly indented margin presents a still bolder character as it approaches and contrasts with the lower fertile plains and valleys of the Meander and South Esk, which seldom exceed an altitude of from 600 to 700 feet above sea level.

"At the great northern and southern water divide, in the neighbourhood of the Table Mountain, it suddenly recedes and contracts, forming a large bight in the direction of the Upper Derwent tributares, notably the rivers Nive and Ouse, from which its level tends to fall, and its marginal boundaries, though frequently rising into high mountain ridges towards Mount Wellington, no longer maintains the uniform boldness of outline which characterises its northern aspect. . . Nearly everywhere along and against this plateau and the greenstone crests of Mount Dromedary, Mount Nicholas, Eldon Range, Mount Gell, Grass Tree Hill, Constitution Hill, and most of the elevated south-eastern dividing ranges, the various members of the Carboniferous (Permo-Carboniferous) and Mesozoic rocks are seen to repose invariably in a horizontal position, or, at most, with a very slight dip towards or away from them."

From this description it will be apparent that, given a period of extremely low temperature, the great elevated plateau of Tasmania possesses, in a special manner, a great width of space at a high level for the formation of an extensive snowfield. It is also significant that in its present western margin, in the vicinity of the mountain valleys, where evidences of former glacial action are so abundantly manifest, there is now even the greatest amount of rainfall. This is shown by the records at the stations at Corinna, Strahan, and Waratah, on the western aspect, as contrasted with the records of Great Lake, Ross, Oatlands, and Bothwell, towards its eastern limits, as in the following table:—

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*A height of 5,000 feet in this latitude would have an inland temperature of that of nearly 6,500 feet altitude in the region of the Australian Alps.

WESTERN RAINFALL (1890).

Station.	Altitude feet.	Annual rainfall (inches).	Maximum month.
Corinna	15	69·50	October
Strahan	20	51·39	October
Waratah	2,000	76·45	October
	Mean	65·78	

EASTERN RAINFALL.

Station.	Altitude feet.	Annual rainfall (inches).	Maximum month.
Great Lake	3,822	34·64	June
Ross	580	19·95	June
Oatlands	1,337	23,48	June
Bothwell	2,000 (?)	23·63	June
	Mean	25·42	

So far as we can judge from existing meteorological conditions, which show that precipitation on the western portion of the plateau is nearly three times the amount of that in its eastern portion, it is obvious that if astronomical causes produced a lowered temperature in the Southern Hemisphere during the last period of maximum eccentricity, combined with winter in aphelion, the greatest precipitation of snow would take place near to the western margin of our great mountain plateau, and would there, probably, collect in sufficient mass to outweigh the short, hot summer melting, and to supply its western alpine valleys with numerous ice streams or glaciers; and while, therefore, supplying *prima facie* evidence of favourable conditions for the development of glaciers on the west, it is also suggestive as an explanation of the apparent total absence of evidence of glaciation on its eastern slopes, where the summer melting might exceed the amount of precipitation. In any case, it adds greater force to conclusions drawn from the positive evidences of glaciation observed by various persons in the alpine valleys of our western highlands, a brief account of which may now be given in chronological order.

EVIDENCES OF GLACIATION IN THE ALPINE VALLEYS OF WESTERN HIGHLANDS OF TASMANIA.

I have already alluded to Mr. Charles Gould's observations, made about 40 years ago, of abundant evidence of the usual dynamic effects of ancient glaciers in the principal alpine valleys of the western highlands of Tasmania, although it is to be regretted that this most accomplished observer, so far as I know, has left no special memoir of his extended observations on this subject.

In the year 1874, in company with the late Honorable J. A. Scott, W. C. Piguenit, Lieut. Burgess, and two other persons, I spent six weeks (all of the party laden with knapsacks weighing from 60 to 70 lbs.) in exploring the whole of the south-western region of the western highlands lying between the mouth of the Huon and Macquarie Harbour, and in making collections and observations on the geology and botany of this region. In the year 1879 I formed one of a similar party in exploring the northern region of the western highlands, including Gad's Hill, Middlesex Plains, Vale of Belvoir, Valentine's Peak, Mount Bischoff, head waters of the Mackintosh Valley, and other tributaries of the Pieman and Arthur.

In the year 1887, in company with my friend, the late C. P. Sprent, Deputy Surveyor-General, and five others, I traversed, on foot, and examined the whole of the region lying near to the route across the island by way of the Ouse, Bronte, Lake St. Clair, Mount King William I., Mount Arrowsmith, Collingwood Valley, King River, Mount Lyell, Queen River, Macquarie Harbour, thence northward across the Hentys, Mounty Heemskirk, Corinna, Whyte and Hazlewood Rivers, Magnet Range, and Mount Bischoff, to Emu Bay on the North-West Coast. I had the opportunity at this time to visit many of the lakes, including Lake Dixon, and to spend three days in examining more particularly the rock formations on Mounts Owen, Lyell, and Sedgwick.

I had thus ample opportunities for observing the many evidences of former glaciation in these regions, enabling me to confirm the earlier observations of Mr. Gould, and also enabling me to record the general results of such observations in my work on the "Geology of Tasmania," begun in the year 1884, and published in the year 1888. I only gave my general conclusions in this work, although my notes contained particulars regarding the abundant occurrence of moraines, *roches-moutonneeś*, scooped tarns and lakes innumerable, huge ice-born erratics, polished rock surfaces, etc., in many localities; notably in the Gorge descending from Scott's Peak in the centre of the lofty and picturesque Arthur Ranges, and along the Alpha and other tributaries of the Craycroft and Huon River; in deep gorges descending from Mount Wedge towards Lake Pedder and the Serpentine; on the neighbouring slopes of the Frankland Range; in deep upper gorges and valleys of the tributaries of the Mackintosh River leading from Granite Tor and Barn Bluff; but particularly in the romantic valley of the Lakes Dixon and Undine, at the source of the Franklin, in the immediate vicinity of Mount Gell and Mount Hugel. The valley of Lake Dixon is, *par excellence*, the ideal of a perfect glacier valley. No one, however ignorant of glacial action, could in this neighbourhood gaze upon those beautiful scooped, or rather abraded, lakes or tarns (many with islets, as also observed by Mr. Montgomery in the region of Barn Bluff and Mount Pelion); the snow-white, polished, billowy, and cascade-like *roches moutonneés*, composed of quartzites, on the upper margin of Lake Dixon, together with the tumbled moraines and large erratic on the lower banks—at a level of about 2,000 feet—without being impressed with the idea that its singularly characteristic features must have been produced by the slow rasping flow of an ancient river of ice.

The numerous beautiful lakes, many with wooded islets, on the lap and all around the base of the steep slopes, as at Mount King William I., the beautiful Lake Augusta under Eldon Bluff, Lake Petrarch in the romantic Cuvier Valley, lakes and lakelets near Mount Hobhouse, and southward in the Valley of Rasselas, as well as the clusters of lakelets at the head of Traveller's Rest, and other sources of tributaries of the rivers Derwent, Gordon, King, and Pieman, are all eminently suggestive of being originally carved or sculptured by ice action during a former glacier epoch in Tasmania.

The abundance of conclusive evidence so impressed me, that when I referred to them in the descriptive part of "The Geology of Tasmania," I was content to summarise them merely as a general confirmation of the previous observations of Messrs. Gould and Sprent. Thus, at p. 164, in referring to the remains of our coal measures on the western crests of the Great Plateau, I state: "From information obtained from the Hon. J. A. Scott, now deceased, and from the appearance of their bold stratified cliffs, as seen by the writer from Mount Arrowsmith, it would seem that, like the coal seams at Ben Lomond, Mount Nicholas, and Fingal, the coal measures of this basin are the remains of a deposit of considerable thickness and extent, lying at the higher levels against the flanks of elevated peaks of the ancient greenstone, that is, above the marine beds which also occur there in the same relative position as the places already mentioned. It is evident that the valleys intervening between the great greenstone plateau and the neighbouring isolated greenstone peaks have been carved out of this upper deposit and the underlying (Permo-Carb.) marine beds. The work of denudation has been so vast that only fragments of this once more widely extended system, abutting against (or underlying) the greenstone, now bear evidence of their original extent. Both Mr. Gould and Charles Sprent bear testimony to the fact that *glacial action* at one time must have been an important agent in the denudation of the immense cañons or gorges which trend away from the elevated plateau westward. Mr. Sprent informs me that for a great distance along the bed of the Mackintosh River, which suddenly cuts its way to the lower levels towards its main artery, the Pieman River, are to be found immense blocks of granite, some of which are many tons in weight. These granite blocks are truly *erratic*, as the granite is not now to be found *in situ* anywhere along the present course of the river. It is probable that the former have been derived from glaciers which descended into the lower valley from the direction of Granite Tor, whose summit still rears its head 4,500 feet above the existing sea level." At pp. 216, 219, 254, 255, 256, and 296 there are also extended references attesting the prevalence of evidence as to the local glaciation of the western Alps of Tasmania during the glacier epoch of Australia.

Mr. C. P. Sprent began his laborious explorations in the north-western highlands in the year 1875. No one had a more intimate knowledge of this wild country, for he was the pioneer who first opened out the greater part of this country to miners, by a process of track-cutting almost like tunnelling in the horizontal, bauera, and other scrubs—the terrible barriers to progress in this region. In 1876 he particularly observed the striking evidences of glacial action in the alpine regions of the west; but, although he gave me, verbally, almost graphic descriptions of these evidences, it was not until the year 1886 that he gave a brief written description * of his observations made ten years previously. At p. 58,* he thus refers to evidences of glaciation observed by him in the year 1876 in the Mackintosh Valley: "At the place where I struck the Mackintosh there are two immense cliffs standing a little back from the river, and at least 600 feet high. Looking at these cliffs from above or below stream they look like two small mountains; but from the top of the gorge they are completely lost in the dark shade of the slope. The river bed is full of immense rounded boulders of granite, although I could not ascertain that any occurs *in situ* thereabouts. The cliffs are of sandstone, and, judging from all appearance, I am of opinion that this deep gorge represents the track of an ancient glacier flowing down from the vicinity of the Cradle Mountain and Barn Bluff. *Traces of glacial action are common all over the West Coast in localities close to high mountains, but it is probable that these glaciers did not descend to the lowlands. The granite boulders of the Mackintosh are of a very large size, some at least five tons in weight, and it is impossible to account for their presence except on the glacial*

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* "Recent explorations on the West Coast of Tasmania," by C. P. Sprent, (Trans. and Proc., Roy. Geo. Soc. of Austral., Vic. Br., Vol. III.—IV.

supposition." He then proceeds to state: "On the sides of the gorge there are many small boulders. In one I found a quantity of carbonate of copper. I had not sufficient time to search for striated markings on the rocks, but my impression was confirmed in later years by the *account of Mr. W. R. Bell, who described the position of the moraine of this ancient glacier. The same indications are to be found in the King River and the Franklin River.*"

It is evident, therefore, that the recent account of all the characteristic phenomena of glaciation observed in 1892 and 1893 by Messrs. Dunn and T. B. Moore* in the same region, that is in the neighbourhood of Mounts Tyndall, Sedgwick, and Murchison, and charted so clearly on Mr. T. B. Moore's accompanying maps, confirm Messrs. Gould, Sprent, and Bell's earlier observations; and although the later observers, Dunn and Moore, write as if they were unacquainted with the much earlier observations of the persons named, as well as of the descriptions to be found in my work on the Geology of Tasmania, it does not detract in the smallest degree from the valuable *additions* which they have made to our knowledge of the evidence of former glacial action in the alpine regions of Western Tasmania.

The occurrence of what appears to be the older conglomerates, so closely associated with newer drifts, and also bearing ice marks, according to Dunn and Moore, and which may possibly be local representations of the *debris* of floating or partly stranded ice sheets, so abundantly manifested in rocks of Permo-Carboniferous age, in South-Eastern Tasmania, and also in similar rocks in Victoria (Bacchus Marsh), and New South Wales, suggest doubt as to whether some of the moraine stuff, found on the flanks of western mountains, upon whose crests this older conglomerate rests, may not be confounded at times with the true moraine stuff of the more recent glacier epoch; for it is possible that recent disintegrations of the older ice-marked conglomerate, gravitating over the steep slopes, may also be largely represented, and sometimes mixed up with the more recent moraines. It is barely conceivable, however, that the older conglomerate would still preserve the finer marks of scratches, striæ, or groovings; but if the less perishable rocks were, until recently, preserved undisturbed in some peculiarly favourable matrix, it is conceivable that some traces of *original* markings might still remain unobliterated.

There is one or two facts of very great importance disclosed by Mr. T. B. Moore's charts and observations which deserve special attention. First, as regards the height up to which the marks of glaciation are found, Mr. Moore informs us that the surface of the conglomerates, within 25 feet of the summit of Mount Tyndall, is polished and striated, that is, at an altitude of 3,850 feet. It is evident here that the collecting ground for the snow to generate glaciers in the small {remaining peak of 25 feet would not of itself adequately account for these higher polished surfaces, nor for the supply of glaciers on all sides which shed such extensive moraines as those lying all around Lakes Rolleston, Garnet, Dora, Dunn's Boss; and, similarly, the small portion of Mount Sedgwick remaining above the original névé would not, of itself, adequately account for its higher glacial markings, nor for the extensive moraines around Lake Margaret, Hamilton Moraine (enclosed by a circular belt, Basin Lake), Lake Spicer, etc. The general trend of striæ may as readily on lower levels have the arrow head of lineal direction turned the other way. Is it not conceivable that the great elevated catchment basin of the great plateau, a little further east, may have sent down, by the existing deep channels of the North and South Eldon, its far mightier glacier streams, which, obstructed partially by the slightly elevated plateau of Lake Spicer and Lake Dora, might, nevertheless, ride over them, abrading and scooping out the basins of the present lakes and lakelets in the line of their path, until they were finally stopped by impact and convergence with whatever local glaciers flowed from the crests of Mount Sedgwick and Mount Tyndall, and thereafter their united streams, producing the large accumulation of moraine stuff on the 2,182 to 2,400 feet plateau at their bases, and at their arrested or final melting points? These remarks, however, are merely suggestive, and are mainly occasioned by the difficulty of adequately accounting for the moraine stuff and the extent of the glaciers, when so small a collecting ground remains above the ancient névé or snow line on the caps of Mounts Tyndall and Sedgwick. At any rate, Mr. Moore has supplied us with most valuable evidence which help towards the solution of these and other difficulties, and his topographical charts of the leading features of this interesting neighbourhood are simply invaluable to anyone who wishes to study them. The prevalence of moraines at the 2,000 feet level, both here and Mount Pelion and Lake Dixon, indicating generally the retiring points of the principal glaciers, are very significant, and strongly support my former views as to the absence of evidence of glaciation in the lowest levels, and also as to the probability that none of our Tasmanian glaciers ever reached the sea.

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* "Discovery of Glaciation in the vicinity of Mount Tyndall, Tasmania." By T. B. Moore. (Roy. Soc., Tas., 1893).

The able paper by Mr. A. Montgomery, M.A., Government Geologist, which has been read to us this evening, I had the privilege of reading beforehand. It contains a very interesting account of his recent geological observations, many of which are new and extremely interesting; but, above all, it not only greatly extends our knowledge of glacial phenomena in Tasmania, but we have also a valuable examination of all collateral evidences, which bear directly or indirectly on the possible extent of glaciation in Tasmania generally during the glacial epoch, its intensity, and its cause; and upon the whole I am gratified to find that his extended and independent inquiries lead him to a conclusion similar to my own, viz., that although refrigeration of our climate was sufficiently intense during the glacial epoch to produce streams of glaciers upon our alpine regions in the west, and possibly in other mountains further south, he is inclined to believe that the refrigeration was not so intense as to cause the ice to invade the levels of our lowlands. He seems disposed, however, to expect the initiation of snowfields and glaciers in isolated mountains further east, but I have given my reasons already why I incline to think that the smaller amount of precipitation, and possibly the milder local climate of the eastern part, may have combined to turn the balance of summer melting against winter precipitation, and so cause a pluvial epoch, at most, in Eastern Tasmania. This inference, in my opinion, would harmonise more closely with all the known facts, and particularly with the total absence of any clear signs of glacial phenomena among our pluvial terrace drifts in the lower levels of Eastern Tasmania.

Mr. Montgomery is also inclined to ascribe a greater denuding power to glaciers in the formation and deepening of mountain valleys and ravines than I am myself disposed to allow. I admit they are very important agents in intensifying the great work of denudation in mountain valleys, whose channels have already been deeply cut by flowing water; but, on the whole, the real carver of valleys and ravines, and the great waster of land surfaces is great precipitation, the more mobile gravitation, and the infinitely greater dissolving power of water in motion. Valleys originally formed by water agency determine the course which glaciers have followed, rather than that glaciers have determined and cut out the channels of valleys in which they have been known to occur. I am also of opinion that the greater denudation of the western slopes of the great greenstone plateau—which, in my work, "The Geology of Tasmania," I inferred that it extended, probably at the close of the Mesozoic age, westwards as far as the West Coast Range, which it partly embraced—was effected, and the leading features carved out, much as they are now found, long prior to our glacier epoch, and this denudation must have been in constant and intense operation ever since the upheaval of the plateau. Even if we allowed only a period of 2½ millions of years to have elapsed between the upheaval of the great greenstone plateau, while allowing a waste at the average estimated rate of one foot of rock in 3,000 years, we must also allow that denudation, especially that powerful form of eating back against water courses, would have removed a quantity of matter—from its ravines especially—equivalent to *a uniform depth of* 833 *feet over its whole area*; and this estimate in such an elevation is probably far too low. The denudation, which has been effected even since the earlier glacier epoch relatively, *could not be a third of this amount*; and since the maximum stage of the glacial epoch, 210,000 years ago, probably *not a tenth* of the amount of denudation which must have been effected prior to the later glacial epoch.

The probability that our valleys would originally eat inward in cuts against the vertical faces of the elevated plateau also invalidates any inferences drawn from the latest cuts made in its watercourses far in the interior of the upland regions; for the beginnings or initial stage of a valley system at its original outer edge would give widely different results. However this may be, Mr. Montgomery's observations of recent action are valuable, although some of the inferences drawn by him may not apply as widely as he may be inclined to consider at the present moment. In the greater number of conclusions formed by him, however, I cordially concur. The evidence given by him of glacial phenomena in the vicinity of Mount Pelion and Lake Eyre are particularly full and clear, and leave not the slightest doubt as to their genuine character. His demonstration of the existence of glaciers flowing from the elevated regions of Barn Bluff and Mount Pelion (whose peaks are fully 1,000 feet higher than Mount Tyndall), of their discharge of moraine stuff, of their singularly perfect *roches-moutonneés*, and erratics at the 2,000 to 2,792 feet level near Lake Eyre, is simply complete and unassailable. His paper, as a whole, is the most comprehensive contribution which I have yet seen as regards the whole question of glaciation and its supposed cause, so far as Tasmania is concerned. I do not here refer to Mr. Montgomery's views as to the causes of the glacial epoch further than to remark that he adopts in the main the view which requires the concurrence of astronomical and favouring geographical and physical causes, a view which I myself have adopted in "The Geology of Tasmania."

The whole subject of causation is treated separately hereafter.

EVIDENCES OF GREAT GLACIAL EPOCHS CONCURRING WITH GREAT CYCLES OF CHANGE IN ORGANIC LIFE, AND ALSO CONCURRENTLY WITH EXCEPTIONAL TERRESTRIAL DISTURBANCES.

The adoption of the astronomical theory as the *sole* cause of glacial epochs throughout all time naturally excited a prejudice against it in the minds of many able geologists, because the known records of the rocks, with the exception of, perhaps, the last two great cold epochs—viz., "The glacier epoch of Australasia," at the beginning of the Pliocene (Neogene of Tasmania), and the "ice age" of Europe and North America, in Pleistocene age—there is not the feeblest evidence of glacial phenomena intercalated within the sedimentary formations, even going as far back as the close of Permo-Carboniferous times. This utter lack of correspondence with the frequent recurrences of periods of maximum eccentricity of the earth's orbit with winter in aphelion in any one hemisphere every 21,000 years, through all this time, certainly appeared to demonstrate that the astronomical theory *alone* could not adequately account for the facts.

The "*imperfection of the record*" theory of effacement which was sought by Sir Robt. Ball and others to form a buttress to it, breaks down completely when closely and widely inquired into. But perhaps the greatest blow to the "*imperfection of the record*" theory of effacement in attempting to show harmonious reasons for the total absence of glacial phenomena in the tertiary rocks generally—in Europe at least—corresponding to recurring cycles of eccentricity, is the discovery of glacial phenomena, consisting of vast beds of striated conglomerates, polished rocks, perfect *roches-moutonneés*, and huge ice-borne erratics in the rocks of *Permo-Carboniferous* age, of nearly all countries in both hemispheres; and thus even showing a greater universality of broadly contemporaneous intense glacial conditions than was exhibited during the last "ice age" of Europe and North America in the Pleistocene period. For, surely, if obliteration by denudation, carried on over a long period, was considered to be an adequate reason for the removal of all traces of glacial action in the earlier Tertiary rocks of Europe, the actual preservation, *universally* of abundant and undoubted glacial phenomena in the much more remote *Permo-Carboniferous* rocks, during such a vastly greater period of time, utterly collapses the "*imperfection of the record*" theory of effacement, as applied to the secondary and tertiary rocks.

The older glacial epoch of *Permo-Carboniferous* age, together with the glacier epoch of Australia in the early Pliocene, and the later "ice age" of Europe and North America in Pleistocene age, are undoubtedly thus shown to be truly exceptional conditions recurring irregularly and not concurrent with the comparatively frequent cycles of the earth's eccentricity, *except at very wide intervals of time*, when, probably, the peculiar combination of astronomical, physical, and geographical causes combined to produce those extreme and exceptional conditions, corresponding to the three almost universal glacial or cold epochs, of which the rocks contain the most abundant and undoubted evidence.

GLACIAL EPOCHS HARMONISING WITH GREAT CYCLES OF CHANGE IN THE PLANT LIFE OF AUSTRALIA AND TASMANIA.

The acceptance of the "*exceptional occurrence*" view of glacial epochs is also strongly corroborated by the great cycles of organic changes, especially as regards plant life.

Thus, about the time of the glacial epoch of *Permo-Carboniferous* age, the original flora of Australia and Tasmania consisted, mainly, of the following characteristic genera, viz., *Glossopteris*, *Gangamopteris*, *Noeggarathiopsis*, *Schizoneura*, *Lepidodendron*.

After the *Permo-Carboniferous* glacial epoch, corresponding to the ushering in of the milder Mesozoic age, the old flora of *Permo-Carboniferous* age suddenly died away completely. *Not a vestige remained!* The Mesozoic rocks then became almost suddenly characterised by the abundance of the following plant forms, viz.:—*Pecopteris*, *Neuropteris*, *Sphenopteris*, *Thinnfeldia*, *Cyclopteris*, *Tæniopteris*, *Odontopteris*, *Sagenopteris*, *Alethopteris*, *Phyllotheca*, *Annularia*, *Podozamites*, *Pterophyllum*, *Otozamites*, *Sphenozamites*, *Brachyphyllum*, *Taxites*, *Sequoites*, *Walchia*, *Cunninghamites*, *Araucarites*, *Baiera*, *Salisburia*, *Ginkgophyllum*, *Zeugophyllites*, (Poa-cordiates).

At the close of the Mesozoic age in Tasmania all its rich and varied flora in its turn disappeared, or "yielded to the great law of death;" and although for the most part no marine beds intervene between our Upper Mesozoic rocks and the immediately succeeding Lower Tertiary leaf beds, the flora of the latter were "brought to the birth and ushered upon the scene" suddenly, and appearing locally as if a new creation. But it is significant that this sudden change *is exactly isochronous* with an unparalleled eruption of igneous rocks (later greenstone) concurrent with widespread convulsions of the older strata. These greenstones even now are so widespread as to form the leading physiographical features throughout the mountains and lowlands of the island. At the time of eruption, probably recurring at intervals over a long period, it seems as if the conditions for plant life were everywhere impossible. There is no evidence at this time of glacial phenomena,[*] but as Mr. J. S. Gardner has arrived at the conclusion, from the study of fossil floras and "strong negative and positive evidence," that, although there were no intense glacial effects, there were alternating warm and colder conditions produced, most probably due to astronomical causes alone, and therefore it seems probable that our great eruptive period, which destroyed our *Mesozoic* flora, may have been concurrent with a cold epoch,[*] due perhaps to less intense eccentricity of the earth's orbit, and thus showing a correspondence with the next great eruptive period (basalt) which, concurring with more potent astronomical and geographical conditions, during our glacier epoch at the commencement of our Neogene period (Pliocene), the whole of our rich and varied Tertiary flora was similarily suddenly and almost completely destroyed, locally at least.

These three great changes in our flora, therefore, corresponding with the exceptional glacial epochs, and also corresponding closely with the periods of great physical convulsions, go to show that there is an underlying bond of connection with exceptional concurrences, at remote intervals, of astronomical, physical, and geographical causes,[†] and that the combination of the three latter causes is essential to the initiation of conditions which produce glacial epochs contemporaneously in widely separated parts of the globe. The universality of glacial action towards the close of the *Permo-Carboniferous* age is testified by the following observations of their occurrence in rocks of different countries.

EVIDENCE OF GLACIAL ACTION IN ROCKS OF THE PERMO-CARBONIFEROUS AGE.

Tasmania.—It is fully nine years ago (1884) since I first communicated to the Royal Society of Tasmania my discovery of evidences of ice action in the rocks of Permo-Carboniferous age at Maria Island. In the year 1886 I made a further discovery of similar evidences of ice action in the shape of huge erratics and polished blocks of the harder rocks foreign to the neighbourhood, in the same formation, at One Tree Point,

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[*] Dana recognised the close of the cretaceous period as "an epoch of cold."

[†] This conclusion is in harmony with the originally expressed opinions of Agassiz and Dana, according to Dr. Wallace's account (p. 222—"Island Life)." "Agassiz appears to have been the first to suggest that the principal epochs of life extermination were epochs of cold; and Dana thinks that two at least of such epochs may be recognised at the close of the paleozoic and of the cretaceous periods." To which we may certainly in Australasia add a third at the close of the paleogene period (miocene) concurring with the great glacier epoch of Australasia.

Bruni Island. Since that time I have obtained abundant evidence in rocks of the same age throughout South-eastern Tasmania.

Everywhere these ice-borne conglomerates and erratics are found in more or less barren layers of the *lower marine* beds, locally known as "Mudstone Rocks." In places, however, as at Beltana, near Hobart, Bedlam Walls, Blackman's Bay Heads, Variety Bay, Adventure Bay, Esperance, and Eaglehawk Neck, the dropped erratics and conglomerates are associated in dense white or yellow, close-grained mudstones, with the following organisms:—

Spirifera Darwinii	*J. Morris.*
„ Strzelecki	*de Kon.*
„ convoluta	*Phillips.*
„ glaber	*W. Martin.*
„ tasmaniensis	*J. Morris.*
Terebraluta sacculus	*J. de C. Sow.*
Sanguinolites Etheridgei	*de Kon.*
„ undatus	*J. D. Dana.*
Pachydomus carinatus	*J. Morris.*
Edmondia ovalis	*R. M. Johnston.*
Aviculo-Pecten limæformis	*J. Morris.*
Tellinomya Etheridgei	*R. M. Johnston.*
Platyschisma oecula	*J. de C. Sow.*
Orthonata compressa	*J. Morris.*
Astartila cytherea	*Dana.*
Theca lanceolata	*J. Morris.*
Goniatites micromphalus	*J. Morris.*
„ strictus	*Dana.*

Also, among other forms, a stray fragment bearing a clear impression of the well-known fern, *Gangamopteris spathulata*, M'Coy.

The erratics generally are found in the middle or lower horizons, and are nowhere associated with the fine laminated zones almost wholly made up of the remains of the common lace-like Fenestellæ. There can be, therefore, no possible doubt as to the age of the rocks in which the ice-borne conglomerates and erratics occur.

For the most part the polished or angular pebbles, boulders, or angular blocks, occur singly, embedded in what must have been, at the time of deposition, an exceedingly soft, fine homogeneous mud, showing in these beds scarce a trace of lamination. In some places, however, they occur in thin lenticular patches as an irregular conglomerate bed. The rocks are either polished or angular pebbles, or blocks grading from small pebbles to blocks over a ton in weight, principally composed of various kinds of granite, gneiss, quartzites, mica-schists, slates, quartz-rock, all being rocks foreign to the localities in which they are found. The larger erratics, composed of granite or quartzite, generally occur singly, and appear as if they had been quietly dropped upon the soft muddy floor from floating ice. The polished sides of many of them plainly indicate ice action, and certainly the huge single granite and quartzite blocks found at Beltana, One Tree Point, Bruni, Bedlam Walls, and Maria Island, weighing respectively from half a ton to over a ton, could not have been transported to their present position in the original, soft muddy bottom of the ancient and comparatively shallow sea floor, except by the agency of floating ice. Although here no favourable conditions occur for tracing fine markings of striæ or groovings, the cumulative evidence, otherwise, is certainly conclusive in referring the transport of these conglomerate and huge erratics to ice agency.

The mudstone beds in which the erratics occur are now everywhere cross-jointed in the most curious fashion.

At Eaglehawk Neck, at a place famously known to the curious sight-seer as the "Tesselated Pavement," the wonderful regularity of the cross-jointing is marvellously perfect. It is curious to observe that, whether the jointing be perfect or irregular, they cut through small, hard, polished pebbles or quartz blocks as though they formed a perfectly homogeneous substance with the now hardened mudstone matrix. In the large granite erratic, over half a ton weight, on the shore at Beltana, several joints, some fine as a hair, others coarse, continuous with those of the mudstone, meet and intersect in the solid grey granite and divide it as completely as in similar cross jointings in the now homogeneous, hard, and siliceous mud rock itself. This feature of the cross-jointing is constant everywhere in the planes in which the erratics occur.

It is possible that some of the thick conglomerate beds occurring in the vicinity of Mount Tyndall, Mount Lyell, and Mount Owen, in which marks of ice action are reported to have been recently discovered by Messrs. Dunn and Moore, may yet prove to belong to the same horizon.

Australia.—What is known among Australian geologists as the "glacial conglomerates" of Victoria, and occurring at Bacchus Marsh, Wild Duck, and in other places in Victoria, are the best evidences in Australasia of glacial action on a large scale in rocks deposited towards the close of the *Permo-Carboniferous* age. It is now about 27 years ago since these ice-borne conglomerates were first referred to this mode of origin by Sir R. Daintree, whose view of their mode of origin was soon after confirmed by Dr. A. R. C. Selwyn. R. D. Oldham, in the year 1886, further confirmed the conclusions of Daintree and Selwyn, and correlated the deposits with similar glacial phenomena occurring in the Newcastle beds, New

South Wales, and with the Talchir and Salt Range ice-borne conglomerates of India, whose position is known to be of Permo-Carboniferous age. Other observers, notably Mr. J. E. Dunn, F.G.S., have conclusively shown by the abundant proofs of glacial action that the conglomerates of this region have been transported thither by floating ice, as in the case of the conglomerates and erratics of a similar horizon in New South Wales and Tasmania.

Mr. Dunn states that the conglomerate is spread over a wide area on both sides of the dividing range, and particularly at Bacchus Marsh, Wooragee, Wahgunyah, Rutherglen, The Springs, El Dorado, Tarrawinga, Badaginnie, Wild Duck Creek, Carisbrook, and the Gordons. Its thickness is stated to be over 100 feet at Bacchus Marsh and in a shaft at Wooragee.

It contains granites in great variety, gneiss, schist, quartz rock, etc., the great mass being derived, as in Tasmania, from schistose and other ancient rocks. The material, Mr. Dunn states, "ranges in size from the finest silt up to great blocks several feet across, and weighing in some cases *probably from 20 to 30 tons.*

"From the well rounded, almost polished pebble boulder to the rough angular fragment of rock that has been torn from its parent mass, and not subsequently abraded, all are represented in these conglomerates." Elsewhere Mr. Dunn states that "Not only are the pebbles, etc., scored and scratched, but great numbers are rubbed on one or more sides (facetted)." From the occurrence of the same genus of ferns (either *Glossopteris* or *Gangamopteris*) occurring in similar ice-borne conglomerates in the Dwyka's or Ecca beds of South Africa and in New South Wales, Mr. Dunn believes them to be of the same age, *i.e.*, *Permo-Carboniferous.*

Other Countries.—Similar evidence of glacial action in the corresponding *Permian* of England has long been made known to geologists by Mr. Ramsay.

Thus in England; Talchir and Salt Range, India; Dwyka conglomerates, South Africa; Bacchus Marsh conglomerates, Victoria; and in similar conglomerates in New South Wales and Tasmania, we have abundant evidence in rocks of the same *Permo-Carboniferous* age in widely separated regions of both hemispheres, that a general refrigeration of climate occurred near to the close of the *Permo-Carboniferous* age, indicating *that a general refrigeration of climate of great intensity existed, probably due to exceptional combination of astronomical, physical, and geographical causes, as in the glacier and glacial epochs of Pliocene and Pleistocene ages respectively; and we may, therefore, safely term the older period in which such phenomena has occurred—the ancient glacial epoch of Permo-Carboniferous age.*

THE CAUSES OF GLACIAL EPOCHS.

Mr. Scarles V. Wood, jun., enumerates no less than seven different causes which have been advanced, more or less strenuously at various times by different persons, to account for the marked changes in climate of which the record of the rocks bear unmistakable evidence. These are—

1. A decrease in the original heat of the planet.
2. Changes in the obliquity of the ecliptic.
3. Changes in the position of the earth's axis of rotation.
4. A variation in the amount of heat radiated from the Sun.
5. A variation in the temperature of space.
6. The combined effect of the precession of the equinoxes and of the eccentricity of the earth's orbit.
7. Changes in the distribution of land and water. To these we must add another, or rather the combination of the last two, as ably put forward by Dr. Wallace in his "Island Life," viz.:
8. A particular distribution of geographical and physical conditions operating concurrently with high eccentricity of the earth's orbit with winter in aphelion.

As regards the first five supposed causes, I follow Dr. Wallace in rejecting them on the grounds that they are either inadequate, taken singly or in combination, to explain the whole of the known phenomena associated with glacial epochs, or there is no geological evidence which reveal their occurrence.

There remain, therefore, only two, taken singly with the third, which demand their causal concurrence.

Before entering upon a discussion as to the efficiency or otherwise of the principal hypotheses which would at least explain the observed dynamic effects of former glaciation, and which, after all, are the only phenomena that require special explanation from a geologist's point of view, it is necessary to mark strongly the distinction between (1) a period of abnormally *low temperature* in a given region, and (2) glacial action, *per se*, in the same region. In ordinary discussions on probable causes of glaciation the two ideas are mixed up, or appear to signify the same thing, and consequently not a little of the antagonism between some of the advocates of the *geographical theory* and the *astronomical theory* respectively is due to the lack of precision with which they grasp the essential differences which exist between them.

The mere lowering of temperature throughout the various zones of isotherms of any one hemisphere during a period of extreme eccentricity with winter in aphelion, as first demonstrated by the late Dr. Croll, and as lately confirmed and amplified in some particulars by Sir. Robert Ball and others, would no doubt cause the limits of the polar ice cap to extend considerably towards the lower latitudes. But this result would not of itself involve the dynamic effects of glaciation without (1) the agency of highlands, and (2) without sufficient precipitation of moisture to turn the balance in each separate locality against the loss by melting during the short but excessive heat of summer. Inasmuch also as the now depressed isochional of the névé or snow line, the result of the astronomical cause, would still continue to rise in height towards the Equator, there would (3) still be a point or isothermal line towards the Equator, beyond which the lowered temperature, from astronomical causes, would be inadequate to produce the freezing of water vapour near to the earth's surface, even in cases where the latter attained to a considerable height, yet falling short of its still more elevated snow line isochional.

On the other hand, the evidences of former glaciation in any one place are only direct proof that the particular area affected was formerly subjected to conditions involving a temperature at or below 32° F., but they do not directly determine whether the area so affected was mainly influenced by (1) a general change in the regional temperature of that place, due to astronomical causes; or (2) by geographical and physical causes which, subsequent to the glacial action, of which evidence remains, may have operated in lowering the mountain cap below the influence of normal temperature of the existing snow line isochional, above which it may have formerly reared; or (3) by alteration in the distribution of land and water in the same region, and thereby altering the thermal currents of air and ocean, whereby the isotherm of a former climate, as in Labrador, may have been changed—with or without the conjunction of astronomical causes—to an isotherm like that of Ireland. Notwithstanding all such qualifications which arise in the mind when dealing with the milder and detached examples of former glaciations which occur on the border line of latitudes lying almost beyond the scope of the astronomical cause to produce intense meteorological changes—as on lowlands in lower latitudes—it is almost conclusive that it would require a general astronomical cause, in combination with the geographical, to account for that intense form of glacial action which repeated itself after a small geological interval of time in Northern Europe, and in North America, during the pleistocene period. How far any one of these causes would fail to account for all the known evidence of glacial phenomena in the younger rocks of both hemispheres is best realised when we consider the matter more closely.

The Objections which Suggest Themselves when Attempting to Explain the Phenomena of Glaciation in both Hemispheres by reference to the Astronomical Theory taken by Itself.

As my object is to go straight to the root of the difficulty of explaining the intense form of glaciation over Northern Europe and North America during the pleistocene period by reference to the astronomical theory *alone*, I will at once grant that the necessary amount of precipitation and vapour, the thermal currents of air and ocean, the elevation of the land, the distance of inland regions from vapour-producing sources, and the difference in latitude, would result in producing all those variable effects upon isotherms and amount of snowfall within the same latitude as they are known to do at present; although we must anticipate greater intensity of effect, and a greater extension of the isotherm of frost at sea level, together with a general lowering of the snow level or névé.

Thus, though it must still be contended that geographical and physical causes would continue to operate in producing some such variations in isotherms, and in the variableness of the distribution of snow, even in the same latitude, or even in different faces of great physical barriers such as lofty mountain chains, it is still quite conceivable that the astronomical cause alone might adequately account for the glacial epoch of Europe and North America, as well as for the milder effects of glaciation exhibited in the rocks of Australia.

The real difficulty to the acceptance of the adequacy of the astronomical theory, *taken by itself*, is as much due to its lack of consistency with astronomical facts as it is to its inadequacy to explain the facts of geology, and in the latter case—not so much as regards positive evidence in respect of glacial effects actually *preserved in our rocks*, as for its inadequacy to explain the *absence of glacial effects* at numerous points within the tertiary period corresponding with the cycles of extreme eccentricity[*] of the earth's orbit combined with winter in aphelion; many of which were as great, and, at two cycles, enormously greater than in the pleistocene period, where alone correspondence appears to occur. To be consistent with itself, therefore, it must demand that similar effects of glaciation in both hemispheres in the same latitude, or nearly so, should be produced at intervals, and in intensity corresponding with the recurrence of astronomical periods of extreme eccentricity with winter in aphelion, alternately every 10,500 years in each hemisphere. *There is not, however, the slightest evidence of glacial epochs, such as that of the pleiostecene period in Europe and North America,* occurring within the tertiary period, corresponding to the recurrence of cycles of extreme eccentricity. Indeed, the double or repeated recurrence of a glacial epoch within the pleistocene period in the Northern Hemisphere, and probably the glacier epoch towards the close of the tertiary period in Australasia, appear to be peculiarly exceptional occurrences within the whole range of the Cainozoic period.

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[*] This is on the assumption that Dr. Croll's calculations of periods of eccentricity calculated for the last 3 millions are relatively correct, if not absolutely so; and that there were many cycles within the cainozoic age alone, two of which were enormously greater than the last, which is supposed to correspond with the glacial epoch of pleistocene age.

Both Dr. Croll and Sir Robert Ball clearly perceived the difficulty presented by the lack of evidence of earlier glaciation in our rocks corresponding to former recurrences of cycles of maximum eccentricity. The latter dismisses this serious difficulty far too curtly, by allusions to the alleged imperfection of the records of the rocks, and to the perishable nature of boulder clays, rendering them peculiarly liable to be washed away; and, as regards moraines, erratics, etc., he adds, " The advent of one ice sheet ploughs away the traces of preceding ice sheets." But surely some definite traces ought to be found intercalated among the many well-preserved beds of the equally perishable sediments of the tertiary formations within the region covered or affected by the last great spread of ice during the pleistocene age. References to the rate and amount of denudation by atmospheric and other causes, based upon the amount of sediments held in suspension, and solutions derived from the waste of the land in rivers flowing into the ocean, may be fairly correct, but surely this waste is not composed entirely of the latest formed deposits. The destruction ever going on in our rocks does not operate so intensely upon the latest layers formed as upon particular areas whose slopes and troughs favour the rapidly erosive action of the great destroyer, *water in motion ;* and this action operates in vertical cuts and gashes through the envelopes of whatever strata may be underneath, rather than in sweeping away all trace of the most recently formed layers, many of which must occur in such situations where they were covered and permanently protected by the newer sediments in course of formation, and, perhaps, largely derived from the immediate waste of the very oldest rocks.

Why, therefore, should we not expect fairly complete vertical fragments of ancient boulder clays, moraine stuff, erratic drifts and in the tertiary formations at least, as commonly as we do of contemporaneous clays, deposited gravels, lignites and sediments, equally perishable stuff, otherwise derived? This is not the only difficulty which bars the way to the acceptance of the astronomical theory taken by itself in adequately accounting for the glacial epoch of Northern

Europe and North America during the pleistocene age. For if the general belief of Australasian geologists be correct that the great *glacier epoch* of Southern Australia, Tasmania, and New Zealand occurred prior to the pleistocene age of Europe, and probably at a point of time contemporaneous with the pliocene of Europe, the astronomical theory alone would be an inadequate explanation of the whole facts. It is generally believed, however, that during the pleistocene period Australasia had experienced a pluvial epoch almost the parallel of corresponding northern latitudes—North Africa and Syria—during the glacial epoch. Thus, in a very able address recently delivered by Professor Jas. Geikie, D.C.L., LL.D., F.R.S., as President of the Geological Society of Edinburgh, he states:—*

"But while the conditions in Northern and Central Europe were markedly glacial, further south only more or less isolated snow-capped mountains and local glaciers appeared—such, for example, as those of the Sierra Nevada, the Apennines, Corsica, the Atlas, the Lebanon, etc. In connection with these facts we may note also the Azores were reached by floating ice; and I need only refer in a word to the evidence of cold, wet conditions as furnished by the plant and animal remains of Southern Europe. *Again, in North Africa and Syria, we find in now dessicated regions widespread fluviatile accumulations, which, in the opinion of a number of competent observers, are indicative of rainy conditions contemporaneous with the glacial period of Europe.*"

I have marked the latter portion with italics for the purpose of drawing particular attention to the fact that the geographical position of Australia, at least, in southern latitudes corresponds exactly with the position of North Africa and Syria, in northern latitude. If, therefore, the causes which produced the great glacial epoch in Northern Europe did not extend *glacial* effects into Syria and North Africa, why should some Australian geologists expect intense *glacial* effects in Australia, seeing that corresponding latitudes in the Northern Hemisphere only experienced mild glacial effects on high mountain slopes, and only *an increased rainfall* on lower levels. If the opinion of our most competent geological observers in Australia be correct, an increased pluvial action in Australia, Tasmania, and New Zealand are the only contemporaneous effects observed during the pleistocene period, as in corresponding latitudes in Syria and North Africa; and thus far there is harmony with the astronomical theory. But if, in the opinion of the same observers, the isolated snow-capped mountains and local glaciers of Southern

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* "Supposed Causes of the Glacial Period:" Professor Jas. Geikie, D.C.L., LL.D., F.R.S. (Trans. Edin. Geol. Soc., p. 212.)

Australia and Tasmania, and the more intense glacier period of New Zealand, indicating a still more marked refrigeration of climate, occurred anterior to this, namely, in the pliocene period, it would prove that geographical and physical causes *must be added* to the astronomical before we can adequately account for the special refrigeration of Northern and Central Europe at a later epoch.

From independent reasoning, based mainly on the absence of evidence of glaciation in the earlier tertiary rocks o Europe, corresponding to former cycles of even greater intensity of the eccentricity of the earth's orbit than occurred during the pleistocene period, Dr. Wallace and Mr. Searles V. Wood, jun., arrive at an exactly similar conclusion, viz., the necessity of the concurrence of geographical and astronomical causes.

There is one remarkable point connected with the supposed earlier occurrence of the *glacier period* of Australasia, which, if confirmed, will be a strong argument in favour of the potency of the astronomical theory, considered at any rate as a constant and necessary major element or great co-efficient in the causation of great glacial or glacier epochs. In the extended calculation of the cycles of eccentricity of the earth's orbit, Dr. Croll places the highest limit reached in three million years at a point of time nearly 850,000 years ago, or about 550,000 years anterior to the last great cycle, extending from 80,000 to 250,000 years ago, which is supposed to correspond with the glacial and inter-glacial epochs of Europe and North America. Now, as already stated by me:—* "Although it be admitted that the primary cause of the glacial epoch in the Northern Hemisphere in the pleistocene period may be due to the high phase of eccentricity of the earth's orbit in combination with winter in aphelion—the effect of precession—it does not necessarily follow that the extreme effects of glaciation have been produced in both hemispheres, or in different epochs by the recurrence of such astronomical causes *alone.* It is admitted that warm ocean currents have such an important bearing upon the question that, if they were not debarred to a great extent from the hemisphere specially affected by the astronomical causes referred to, glaciation of an extraordinary character would not be appreciable. Now the preponderance and the nature of the distribution of the land in the Northern Hemisphere render the latter more liable to the obstruction or diversion of the warm equatorial ocean currents produced by geographical changes, while, with the smaller extent of elevated land and its insular position, the Southern Hemisphere would be comparatively unaffected."

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* Geol. of Tasmania, p. 255.

Now from these considerations it is important to observe that, as regards Australasia, the influence of geographical barriers may be said to be *nil*, and that to this region, whatever great general climatic changes may have taken place, can be referred with greater certainty to astronomical causes *alone*. But if we admit this, we must also allow that the major astronomical cause must produce the major effect. Seeing, therefore, that Dr. Croll has calculated the amount of eccentricity of the earth's orbit 850,000 years ago to be 28·57 per cent. greater than during the last cycle which is supposed to correspond with the glacial epoch of the Northern Hemisphere, ought we not to expect to find in Australasia, where alone the purely astronomical effect would be most clearly revealed, the most marked extreme of climate? If we reason correctly we must answer in the affirmative, whatever may be our preconceptions, which are ever too prone to take side glances at consequences before making a reply. We must therefore, in Australasia at least, expect to find, probably near to the close of the tertiary period (according to the very moderate estimate of geological time by Dr. Wallace), evidences of a greater intensity of refrigeration of climate than during the period corresponding to the glacial epoch of the Northern Hemisphere, whose intensity there is mainly due to *combined causes*. The evidences of our rocks by which the most competent geologists of Australasia were originally led to place our glacier epoch in the pliocene period, and a great pluvial epoch in the pleistocene period, are remarkable as a confirmation of the potency of the astronomical cause in itself to produce at periods of *maximum eccentricity* great climatic changes, corresponding in effect to the degree of eccentricity at the respective periods.

Of course it is taken for granted that the astronomical cause, even although operating in a broadly contemporaneous manner in both hemispheres in any one epoch, must nevertheless, in its minor phases of variation every 10,500 years due to precession, place the scene of greatest severity in either hemisphere consecutively and not contemporaneously.

It is admitted that a glacial epoch is broad enough to contain many of such *consecutive* alternations.

THE WEIGHT OF NEGATIVE EVIDENCE.

The weight of negative evidence against the astronomical theory by itself, as regards the absence of glacial deposits in other tertiary formations, is ably summarised by Dr. Wallace in the following terms:—"But when we proceed to examine the tertiary deposits of other parts of Europe, and especially of our own country, for evidence of this kind, not only is such evidence completely wanting, but the facts are of so definite a character as to satisfy most geologists that it can never have existed; and the same may be said of temperate North America and of the Arctic regions generally."

Mr. Searles V. Wood, junr., who wrote a remarkably able paper on "The Climate Controversy," is quoted by Dr. Wallace in support of this conclusion, as follows:—

"Now the Eocene formation is complete in England, and is exposed in continuous sections along the north coast of the Isle of Wight from its base to its junction with the Oligocene (or Lower Miocene according to some) and along the northern coast of Kent from its base to the lower Bagshot Sand. It has been intersected by railway and other cuttings in all directions and at all horizons, and pierced by wells innumerable; while from its strata in England, France, and Belgium the most extensive collections of organic remains have been made of any formation yet explored, and from nearly all its horizons, for at one place or another nearly every horizon may be said to have yielded fossils of some kind. These fossils, however, whether they be the remains of a flora, such as that of Sheppey, or of a vertebral fauna, containing the crocodile and alligator, such as is yielded by beds indicative of terrestrial conditions, or of a molluscan assemblage, such as is present in marine or fluvio-marine beds of the formation, are of unmistakably *tropical or sub-tropical character throughout; and no trace whatever has appeared of the intercalation of a glacial period, much less of successive intercalations indicative of more than one period of* 10,500 *years glaciation.* Nor can it be urged that the glacial epochs of the Eocene in England were intervals of dry land, and so have left no evidence of their existence behind them, because a large part of the continuous sequence of Eocene deposits in this country consists of alternations of fluviatile, fluvio-marine, and purely marine strata; so that it seems impossible, that, during the accumulation of the Eocene formation in England, a glacial period could have occurred without its evidences being abundantly apparent. The Oligocene of Northern Germany and Belgium and the Miocene of these countries and of France, have also afforded a rich molluscan fauna, which, like that of the Eocene, has as yet presented no indication of the intrusion of anything to interfere with its uniformly sub-tropical character."*

Dr. Wallace, in confirmation, goes on to say †:—"When we consider that this enormous series of deposits, many thousand feet in thickness, consists wholly of alternation of clays, sands, marls, shales, or limestones, with a few beds of pebbles or conglomerate, not one of the whole series containing irregular blocks of foreign material, boulders, or gravel, such as we have seen to be the essential characteristic of a glacial epoch; and when we find that this 'very same general character pervades all the extensive tertiary deposits of temperate North America, we shall, I think, be forced to the conclusion that no general glacial epoch could have occurred during their formation.'" And Dr. Wallace further anticipates Sir Robt. Ball's argument, which relies solely upon the "imperfection of the geological record," by the concluding part of his observations, where he states: "It must be remembered that the 'imperfection of the geological record' will not help us here, because the series of tertiary deposits is unusually complete, and we must suppose some destructive agency to have selected all the intercalated glacial beds, and to have so completely made away with them that not a fragment remains, while preserving all, or almost all, the *interglacial* beds; and to have acted thus capriciously, not in one limited area only, but over the whole Northern Hemisphere, with the local exceptions on the flanks of great mountain ranges already referred to." On the whole, therefore, it seems to be conclusively demonstrated that a concurrence of favourable geographical conditions with astronomical causes is essential to the initiation of glacial conditions even in existing temperate zones, and that changes of eccentricity, however great, have no potency in themselves to produce glaciation of an intense form on the lower levels of existing temperate latitudes, because warm air and ocean currents have so preponderating an influence, that, if they were not diverted and barred by physical and geographical conditions from the regions affected, glaciation on lowlands of existing temperate latitudes would be impossible. These conclusions are in no way disturbed by the more recent calculations by Sir Robt. Ball in regard to the exact proportion of *direct* heat received by any one hemisphere during the long winter and short summer of a period of great eccentricity of winter in aphelion in the respective hemispheres; for he himself acknowledges that the heat influence affecting either hemisphere under the most extreme conditions are not confined to the direct sun rays. At page 126 ("The Cause of an Ice Age") Sir Robt. Ball states, "There are two causes by which the severity of a glaciation is somewhat modified. There is, first, the actual storage of some of the copious heat of summer in the glaciated hemisphere itself, to be doled out again during winter; there is, secondly, the *the contribution of heat from the opposite hemisphere, which may be conveyed via air or via water across the equator into glaciated regions.*" Hence it follows that his calculations—proving that within the same hemisphere the heat received direct from the sun amounts to

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* *Geol. Magazine*, 1876, p. 392: Island Life, pp, 173-174.

† Island Life, pp. 174, 175.

63 per cent. in summer and only 37 per cent. in winter—do not help us to gauge the actual heat received in the winter of the glaciated hemisphere, as he has not formed any estimate of the known indirect sources of heat which would be received by air and ocean currents from the genial hemisphere, but the value of which we may have, now, some means of conceiving from the study of two regions in nearly the same northern latitudes, viz., Labrador and Ireland.

The former being in a glaciated condition owing to the influence of the Arctic cold current of water; the latter in a genial condition owing chiefly to the influence of the warm Gulf Stream, whose heat has been mainly derived from south equatorial regions.* While I cannot but admire the masterly and lucid manner in which Sir Robert Ball explains the astronomical theory, and supports the main conclusions of Dr. Croll, I am still disposed to think that in limiting his observation, too closely, to the *direct* sources of heat and their exact measurement, as regards the glaciated hemisphere, he has not sufficiently reflected upon the powerful modifying influences of the indirect supplies received from the genial hemisphere, nor of the possible changes which might occur in geographical conditions, which might greatly multiply or diminish the nominal amount of heat transmitted by the opening of new equatorial channels of communication, or by barring former channels. Nay more, according to Herschel's astronomical theory, as modified by Sir Robt. Ball, and its expected influence upon climate during a period of great eccentricity with the winter in aphelion, in the Southern Hemisphere, as at present, —it is stated: "In the northern we should have a short but very *mild* winter, with a very long but *very cool* summer, *i.e.*, an approach to perpetual spring," but from Mr. Robt. H. Scott's recent work on Meteorology, we find from existing conditions † "*the opposite is the case, owing to the unequal distribution of land and water*," ‡ and also owing to the fact "that in the summer in the Northern Hemisphere *the sun's rays fall on the greatest possible land area*." Here we have a complete reversal of the supposed influence of the astronomical cause, proving that the geographical conditions, which Sir Robt. Ball almost ignores as a *necessary* concurring cause in the initiation of a glacial epoch, has a *preponderating effect* in the determination of existing climates; and although Sir Robt. Ball only admits, to a certain extent, the modifying influence of geographical conditions § and feels the result "a little disappointing" in view of the astronomical theory put forward, he nevertheless has practically* to admit that a glacial epoch *cannot take place* without the concurrence of two great causes, viz., a period of great eccentricity of the earth's orbit, with winter in aphelion, conjoined with specially favouring geographical conditions.

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* Dr. Croll estimated that the quantity of heat transferred by the Gulf stream from equatorial regions was not less than one-fifth of the entire heat possessed by the North Atlantic,

† Elementary Meteorology, R. G Scott, p. 231

‡ Ibid, p. 230.

§ The Cause of an Ice Age, p. 134.

IMPROBABILITY OF FINDING EVIDENCE OF INTENSE GLACIATION IN ANY PORTION OF AUSTRALASIAN LOWLANDS AMONG ROCKS OF THE SAME AGE WITH THE GLACIAL EPOCH OF NORTH AND CENTRAL EUROPE AND NORTH AMERICA.

There are some enthusiasts who are so infatuated by the supposed omnipotence of the astronomical theory when regarded as the sole cause of glacial epochs, that they are somehow imbued with the idea that the same cause or causes which produced the Till or "*Grund Moraine*" of the northern glacial epoch in the lowlands of Scotland, Wales, and Ireland, between north lat. 51° to 59°, and covered these countries with a continuous ice sheet, may also be expected to have produced similarly intense results of glaciation in south lat. 36° to 38° in the lowlands of Australia, in a region corresponding to North Africa and the middle of the Mediterranean Sea in the Northern Hemisphere.

Now, while it is granted that the actual facts of observation may be faithfully recorded by persons holding such extravagant notions, it may be doubted whether they are able to draw inferences from the less perfect portion of supposed glacial evidence without being coloured to some extent by the extravagance of their ideas concerning the potency of causal influences.

If we are to be guided by the true scientific method in the investigation of the potency of causes relating to climate and glaciation, we must surely proceed in a reasonable manner by deducing the unknown from the known, the past from the present.

Now the potency of the causes which produced the glacial epoch in northern and central Europe have been fairly gauged by very able observers; and they have not only closely determined the limits of the spread of the northern ice sheet in a southerly direction, but, by a careful chain of observation of the upper and lower limits of ice action on elevated slopes of mountains in a series of latitudinal points, they have arrived at a fairly approximate idea of the altitude of the glacial epoch névé or snow line; and from such materials have given us broadly satisfactory isochionals for various latitudes, embracing at least the whole of the region subjected to glaciation, excepting of course the local glaciation of mountains ascending beyond the névé in higher temperate and tropical countries.

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* Ibid. 134, 159, 160.

It is also necessary to understand clearly the position which Australia, Tasmania, and New Zealand occupy in southern latitudes, as compared with the position of countries in Europe, in northern latitudes, over which it is known intense glaciation extended during the Great Glacial Epoch.

For this purpose I have placed in parallel columns the names of a few well-known places nearly in the same line of isotherm or latitude, and therefore approximately the respective equivalents of each other in north and south latitude.

APPROXIMATE EQUIVALENTS.

Estimate height of snow line (feet). *Northern Hemisphere.*			
Present Time.	**Glacial Epoch.**	*Southern Latitudes.*	*Northern Latitudes.*
		1. Southern limit of N. Zealand.	Mouth of River Loire, France
		2. Southern limit of Tasmania.	Venice, Bayonne.
		3. Southern limit of Australia.	Lisbon, Valencia.
9,520	6,520	4. Mount Cook, New Zealand.	Pyrenees, Rotondo, Balkans Apennines.
9,520	6,520	5. Mount Olympus, Cradle Mount, Tasmania.	Cape St. Vincent, Sicily, Athens.
11,187	8,187	6. Bacchus Marsh, Victoria.	Sierra Nevada.
11,480	8,480	7. Mount Kosciusko.	Tangiers, N. Africa, Malta, Cyprus, Mount Atlas, N. Africa, Morocco.
		8. Mount Lofty Range, Adelaide.	
		9. Australia.	North Africa, Syria.

The importance of this contrast is great, because it brings forcibly before our minds that the position of Australia corresponds, not with the glaciated area of North and Central Europe, but with those more genial southerly regions of North Africa and Syria, lying beyond the scope of the intense glacial influence of the glacial epoch; and it reminds us also, although we may be prepared to agree with Sir Robt. Ball, that we might find evidence of corresponding glacial intensity to the northen ice age of Europe in the Southern Hemisphere, that Australasia in any part—perhaps with the exception of Stewart Island lying at the southern extremity of New Zealand—*does not come within that portion of the Southern Hemisphere which corresponds with the specially glaciated region of Northern and Central Europe and North America.* If we reason from the known to the unknown, therefore, we have good *a posteriori* grounds for doubting the value of evidence which locates the effects of intense glacial action, during the glacial epoch of Europe, in any part of the lowlands of even the most southerly region of the Australian mainland, at least. These conclusions are in perfect harmony with the most recent investigations of the extent and comparative intensity of the glaciation of Europe in the last ice age. Perhaps there is no one entitled to speak with greater authority on such a matter as Prof. James Geikie, D.C.L., LL.D., F.R.S., the accomplished author of "The Great Ice Age." In his last presidential address* to the members of the Geological Society of Edinburgh—from which I am proud to have received the honour of being elected as one of the honorary foreign corresponding members—he deals with the whole of the "Supposed Causes of the Glacial Period" with a master mind. In referring to the extent of knowledge now possessed by us in measuring the limits and intensity of glaciation of the "Ice Age," he states†:—"So greatly has our knowledge of the Glaciation of Europe increased during recent years, that the height of the snow line of the glacial period has been determined by MM. Simony, Partsch, Penck, and Höfer. Their method is simple enough. They first ascertain the lowest parts of a glaciated region from which independent glaciers have flowed. This gives the maximum height of the snow line.

"Next they determine the lowest point reached by such glaciers. It is obvious that the snow line would occur higher up than that, but at a lower level than the actual sources of the glaciers, and thus the minimum height of the former snow line is approximately ascertained.

"The lowest level from which independent glaciers formerly flowed, and the terminal point reached by the highest lying glaciers having been duly ascertained, it is possible to determine with sufficient accuracy the mean height of the old snow line. The required data are best obtained, as one might have expected, in the Pyrenees and amongst the mountains of MIDDLE and SOUTHERN Europe.

"*In those regions the snow line would seem to have been some* 3,000 *feet or so lower than now!* From such data Professor Penck has constructed a map showing the isochional lines of the glacial period. These lines are, I need hardly say, only approximations, but they are sufficiently near the truth to bring out the contrast between the ice age and the present. Thus the isochional of 1,000 metres which at present lies above Northern Scandinavia was pushed south to the latitude of Southern France and North Italy; while the isochional of 2,000 metres (now overlying the extreme North of France and North Germany) passed in glacial times over the northern part of the Mediterranean. . . . It is interesting to note that while in the Tabra (North Carpathians) the snow line was depressed in glacial times to the extent of 2,700 feet only, in the Alps it descended some 4,000 feet or more below its present level. With the snow line of that great chain at such an elevation it is obvious that *only a few of the higher points of the Apennines could rise into the regions of the névé. This is the reason* why moraines are met with in only the *higher valleys of that range.*"

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* Trans. Edinburgh Geol. Soc., Vol. VI., Part 3, pp. 209, 230.

† Ibid., p. 211.

Professor Jas Geikie elsewhere remarks:—"Isochional lines are not isotherms. Their height and direction are determined not only by temperature, but by the amount and distribution of the snowfall.* Nevertheless, the position of the snow line in Europe during the ice age enables us to form a rough estimate of the temperature. At present, in middle Europe, the temperature falls† 1° F. for every 300 feet of ascent. Hence, if we take the average depression of the snow line in glacial times at 3,000 feet, that would correspond approximately to a lowering of the temperature by 10·2°. This may not appear to be much, but, as Penck points out, were the mean annual temperature to be lowered to that extent, it would bring the climate of Northern Norway down to Southern Germany, and the climate of Sweden to Austria and Moravia, while that of the Alps would be met with over the basin of the Mediterranean."

"Let it be noted further that this lowering of the temperature, this displacement of climatic zones, was experienced over the whole continent, extending on the one hand south into Africa, and on the other east into Asia. *But while the conditions in Northern and Central Europe were markedly glacial, further south only more or less isolated snow-capped mountains and local glaciers appeared, such, for example, as those of Sierra Nevada, the Apennines, Corsica, the Atlas, the Lebanon, etc.*"

It is of particular interest to note the portion of Professor Geikie's remarks, which have been italicised, as it is just this milder form of glaciation which we can reasonably expect in the southernmost part of Australasia, including Tasmania and New Zealand, whose position is almost the exact equivalent of the regions bordering the Mediterranean referred to by him; and also, that even within this southern region of Australia, it is only in the vicinity of mountains whose crests are likely to have ascended into the névé at the time of a glacial epoch that we can reasonably hope to find good evidence of former glaciation due to local glaciers, and there *only in the higher valleys.* As this region, however, corresponds to the southern extremity of Europe and the northerly extremity of Africa, it is probable that during a period of lowered temperature there would be a greatly increased rainfall, with a great increase in the dynamic effects of existing rivers and watercourses, both in highlands and lowlands.

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* The better known term "*isochryme*" only implies equality in extremes of *cold* (R. M. J.).

† From independent calculations based, by the writer, on Mr. R. H. Scott's tables of existing mean temperatures for various latitudes, together with limits of existing snow line over both hemispheres, it would require only a fall of 1deg. F. for every 400 feet of ascent. (R. M. J.)

Such was the condition of similar latitudes during the ice age of Europe, according to Prof. James Geikie; for in the same address, from which I have so largely quoted, he states,* "that in the extreme south of Europe, and in North Africa and West Asia, increased rain precipitation accompanied lowering of temperature; from which it may be inferred that precipitation in glacial times was greater generally than it is now."

Now it is important to observe that in New South Wales, South Australia, Victoria, New Zealand, and Tasmania we have abundant evidence, in the extensive, irregular, coarse, shingly terrace-drifts formed in the main valleys frequently overlying our older tertiary basalts, of conditions which indicate, clearly, that during the period extending throughout the Neogene (Pliocene) and Pleistocene ages there was a greatly increased rainfall; and so generally throughout these colonies are these characteristics manifested during this period that Australian geologists have long been in the habit of referring to it as the "pluvial epoch" of Australasia. The representative geologists in Australasia are almost unanimous in placing the beginning of our glacier and pluvial epochs as far back as the commencement of the Pliocene age, and it would appear that this refrigerated pluvial epoch was either continuous or recurred again and again, well up to the close of the Pleistocene period; and only the later terrace drifts, therefore, may be said to be the isochrones of the glacial drifts of the ice age of the Northern Hemisphere.

I have referred to the evidence of lowered temperature, local alpine glaciation, and greatly increased rainfall of the pluvial epoch very frequently in my larger work on "The Geology of Tasmania."

Thus, in commenting upon the climate of the Neogene period (Pliocene), I stated (p. 219), "Mr. Wilkinson is of opinion that the great drift deposits left at different levels upon the sides of the valleys as they were deepened towards the close of the Neogene period indicate a much greater rainfall than at present, and this greater rainfall is inferred to be due to the greater extent of glaciation of portions of the

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* Loc cit., p. 214

Northern and Southern Hemispheres. Whatever grounds there may be for this view, it is clear, from the absence of huge ice-borne erratics, and other evidences *on the lower levels*, we are not justified in assuming a very serious and general refrigeration of the climate in the Australasian regions."

"That a considerable change of climate, however, had its beginning at this time is most probable, as evidenced by the sudden disappearance of the characteristic flora of the older, or *Paleogene*, epoch; and especially by the striking contrast which its unstratified, irregular drift deposits (almost barren of all traces of life) present, as compared with the more regularly stratified members, replete with life remains, of the Paleogone epoch." Again, in discussing the causes of colder climate, pp. 254-257, I stated, "It is clear that the conditions under which the successive, irregular, coarse, shingly terrace drifts had been formed in the main valleys were very different from those under which the Paleogene formations were deposited, and it is also probable, as suggested in respect of equivalent formations in New South Wales by Mr. S. Wilkinson, and in South Australia by Professor Tate, that the mode of deposition and other circumstances indicate a greater rainfall than at present. The paucity of life in the formations by itself, while depriving us of the aid of palæontology in the classification of the rocks and in inferring local climatic conditions, only affords negative evidence in support of a growing refrigeration of climate. Whether this supposed change in the direction of a colder climate became sufficiently intense within the period to produce the local ice sheets and glaciers, of which there is evidence in valleys of the western highlands of Tasmania, notably along the deeply cut ravines of the Mackintosh River, it is difficult to determine. It is quite conceivable, however, that simultaneously with the rising of the floor of the old Paleogene sea the adjacent land partook of a corresponding elevation"—(and to this we may now add the conception of maximum eccentricity of the earth's orbit, whose occurrence is placed about 550,000 years before the glacial epoch by Dr. Croll, which time would approximate closely to the early part of our Neogene period or beginning of our pluvial epoch)—"and we may therefore expect to find, as a direct consequence, a considerable change of temperature over the area so affected."

It is important also to observe, here, that Prof. Hutton is of opinion that the former greater extension of the New Zealand glaciers occurred during the interval between the Pareora system and the marine beds of the Wanganui system, *i.e.*, at a period isochronous with our Neogene pluvial drifts and terraces.

The difficulty of explaining these facts by reference to a cause which only came into operation at a much later period, *i.e.*, in the Pleistocene glacial epoch, and which forms the greatest stumbling block to the acceptance of the potency of the astronomical theory as being *alone* sufficient to account for such a refrigeration of climate as that which produced the intense glacial epoch of Europe, is next discussed by me in the same place at considerable length—pp. 255, 256—and the following conclusions were arrived at:—"Accordingly from the very much smaller proportion of elevated land in the Southern Hemisphere, and from the improbability of the equatorial ocean currents having been appreciably excluded at any time, owing to the absence of connected land barriers, it is reasonable to infer that the combined effects of astronomical and geological causes, similar to those which brought about the glacial epoch in Europe and North America (but *especially to the favourable latitudinal position*)—are not likely to have *operated intensely* in Australasia.

"That this seems to be the more reasonable view as regards Australia is borne out by local evidences.

"In the first place the Neogene epoch of Australasia corresponds with the Pliocene epoch of Europe, and, consequently, whatever the local climatic conditions may have been, they cannot in all respects be referred to causes which entered into combination in a succeeding epoch in the Northern Hemisphere.

"In the second place, while admitting the evidence of former glaciation in local alpine regions, there is no satisfactory proof that the erratics found in such regions belong to the period in which our raised terrace drifts were formed; and neither in these nor in the later deposits of the extensive lower levels do we find any clear signs of ice action, such as are exhibited so widely in Europe and America, in the shape of moraines, boulder drift, striated blocks, perched blocks, and other huge ice-borne erratics, etc. On the contrary, the prevailing terrace drifts in Tasmania are formed from materials derived from the adjacent or underlying rocks; and with the exception of huge boulders at the base, or on the slopes of mountain ranges, clearly traceable to gravitation, there is not the slightest trace of rock masses which would necessitate the agency of ice as a means of transport,* if we except also those evidences (*i.e.*, of glacial action) in alpine regions in the western highlands, which are more probably local effects due mainly to a much greater elevation of the land in former times (and I am now able to add, perhaps, also the influence of the greater limit of the eccentricity of the earth's orbit with winter in aphelion occurring, according to Dr. Croll, 550,000 years prior to the glacial epoch of the Northern Hemisphere)." I then conclude with the observation (p. 256):—"The author is personally familiar with the various evidences of glaciation in Scotland at the higher and lower levels, and his knowledge of Tasmania is sufficiently wide to enable him to state with confidence that corresponding evidences *in the latter place* (*i.e.*, obviously the *lower levels*) are entirely wanting within the tertiary and later periods."

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* These remarks do not apply to the ice-borne erratics found in rocks of Permo-Carboniferous age, of which there is the most abundant evidence throughout the older mudstones of this age in Tasmania, Victoria, and New South Wales.

In the recent paper already referred to, prepared by Messrs. Officer and Balfour, of Victoria, the authors erroneously convert my statement as to the absence of evidence of *intense glaciation* into an assertion "*that there is no evidence there* (Tasmania) *to show that a glacial period has ever taken place.*" I make no such statement. I was the first person not to observe, but to publish evidenee clearly proving ice action in the alpine regions of our western highlands, but the absence in lower levels of any evidence of ice action confirms my opinion as to the absence of *intense glacial action* during our glacier and pluvial epochs. In this view, regarding the absence of evidence of glaciation on the lower levels of Tasmania, I am gratified to have the support of our able Government Geologist, Mr. Montgomery, for in his paper just read ("Glacial Action in Tasmania"), in referring to this very question, he states: "In the main I agree with his view," that is, with the view which I had inclined to take as expressed in page 256 "Geol. of Tasmania."

Mr. Montgomery's most valuable contribution to our knowledge of ice action, together with similarly valuable papers of Messrs. Dunn and Moore, now enable us to fix the limits of the upper and lower indications of positive ice action on the shoulders and slopes of our western highlands with a close approximation to the truth, at least sufficiently so to give us a fairly good base for determining the isochional of the névé or snow line of our western highlands, during the two great glacier periods already referred to. But first it is necessary to consider how far denudation may have reduced the height of our mountain tops. If we even allow in such situations a rate of denudation of three times that of the average rate, which is estimated to be nearly one foot in 3,000 years (that gives one foot per 1,000 years), we can only allow a lowering of altitude by about 850 feet since the beginning of the Pliocene period, at which time it is probable the refrigeration, due to the maximum of eccentricity in the earth's orbit 850,000 years ago, might probably have caused the earlier glaciation of our western alpine region, which, even now, has a very extended surface (Great Greenstone Plateau) with a mean altitude of 4,000 feet. This allowance for denudation would bring the mean altitude of the same mountain plateau up to about 5,000 feet, and the same cause would also incline us to extend its elevated area further west, so as to embrace at least Mounts Tyndall, Geikie, Murchison, Read, Jukes, Owen, and Lyell. This would give us a very extended elevated catchment platform for the collection and piling up of a permanent snowfield sufficient to form an adequate supply for feeding the numerous glaciers which are known to have descended from its western slopes.

If we also assume for the lat. 42° south that the snow cap would at least be 1,000 feet thick, we should then have reached a surface level of 6,000 feet. The question now is a crucial one. Would a height of 5,000 feet in this latitude ascend into the *isochional* or plane of the permanent freezing point, supposing that the general lowering of the temperature produced by the astronomical cause during the last glacial epoch of Europe also produced exactly corresponding effects under similar conditions as to latitude, etc., in Tasmania and neighbouring Australasian colonies? Let us see. In the corresponding latitudes of the Pyrenees, the névé was only lowered 3,000 feet during the maximum effect of glacial action in the recent European ice age. As the névé at the present time, there, is placed at about 9,520 feet altitude, it is obvious that during the glacial period of Europe the névé of the Pyrenees must have stood at a height of about 6,520 feet. This would indicate that the mean height of even our *restored* western plateau would fall below the névé by about 1,520 feet, and under such conditions *there could have been no snow cap, and hence no glaciers produced by the same general cause which produced the ice age of Europe in the pleistocene period.* It must also be borne in mind that the Southern Hemisphere at present has its winter in aphelion, and that the existing level of the isochional or névé is far below the altitude of the névé in corresponding latitudes in the Northern Hemisphere; and, therefore, in my opinion, it would not be correct to measure the fall of 3,000 feet in relation to calculated height of existing névé in the Southern Hemisphere, for the limit of 3,000 feet fall is calculated in relation to existing isotherms in the Northern Hemisphere. But suppose the mean of existing difference of the level at the névé in both hemispheres be taken for the same latitude it would still leave our restored western plateau about 1,225 feet below the estimated local névé or snow level at the time of the glacial epoch in Europe. This bears out the evidence of Australasian geologists that our glacier and pluvial epoch *was not brought about* by the same cause which produced the glacial epoch of Europe and North America in the pleistocene period. Let us now see whether, by the same method of reasoning, a more favourable argument can be advanced on behalf of the earlier cycle of *maximum* eccentricity of about 550,000 years earlier in the Pliocene age and contemporaneous with our older pluvial terrace drifts on lower levels. It may be remembered that the eccentricity of the earth's orbit at this maximum period of cyclic eccentricity is calculated to have been 28·57 per cent. greater than the cycle of eccentricity which occurred during the last ice age of Europe. If we reason that the effect on temperature should be in proportion to the intensities of eccentricity, we must assume that the lowering of the névé or snow line in the earlier maximum cycle would be as much as 3,857 feet, and this, with the restored level of our western mountain plateau, which would have been wasted for 850,000 years, would place the mean level of its upper surface at a height of about 400 *feet above* the névé or snow line, and thus produce the necessary *initial* conditions for the formation of a snowfield which might eventually accumulate snow and ice whose surface might be as high as 1,400 feet above the snow line, and would then, by the assumed balance of precipitation over melting, be able to send glaciers down its western slopes, possibly within 1,000 feet, or, in favourable valleys, perhaps to 600 or 700 feet above sea level. According to personal observation, and to the testimony of Messrs. Montgomery, Moore, Sprent, Jones, Dunn, and others, the same calculations would indicate corresponding results for Mount Kosciusko and other peaks over 6,300 feet in the southern Alps of Australia.

Thus, if we take 11,000 feet as the isochional or névé for the latitude of Mount Kosciusko we have the following result:—

		ALT.
Existing isochional of Mount Kosciusko (say)		11,000ft.
Less 3,857 feet, due to lowering of temperature during period of max. eccentricity of earth's orbit with winter in aphelion, 850,000 years ago, say in Pliocene period ...		3,857ft.
Isochional of older glacier period of Australia in latitude 36°... ...		7,143ft.
Present height of Mount Kosciusko	7,200ft.	
Add waste by denudation in 850,000 years	850ft.	8,050ft.
Difference showing height above névé		907ft.

The above calculation would also justify us in looking for alpine glaciers on the slopes of the lofty Bogong Range, in the direction of Beechworth, adjoining, and almost a continuation of, the Australian Alps. Mount Bogong itself 6,508 feet high, and the highest mountain in Victoria, may be said to be the south-westerly continuation of the Australian Alps, which rises into the lofty peak of Mount Kosciusko, the most elevated mountain in Australia. The careful observations of Messrs. Stirling and Dunn regarding the abundant evidence of glaciation in these Alps of Victoria are strongly fortified by the calculations given, proving that without any material alteration of present levels the elevated table lands and peaks of this region would ascend above the névé or isochional of the earlier Pliocene period, and so form the initial condition for producing a permanent snowfield, with its attendant glaciers, in the Kiewa, Mitta Mitta, and other mountain valleys; in which places the two observers named have given ample evidence in the discovered moraines, huge erratics, roches-moutonnees, striated blocks, etc.

That the evidence of glaciation on these Alps are more probably isochronous with the earlier cold pluvial epoch[*] which produced our older terrace drifts on lower levels of the Australian mainland and Tasmania is favoured by the same mode of determining the isochional of the névé for the period corresponding with the later glacial epochs of the Northern Hemisphere, thus:—

		ALT.
Existing isochional of snow line about		11,000ft.
Less depression of névé due to extremity of orbit at last glacial epoch in Northern Hemisphere. Max. effect estimated to be about 210,000 years ago...		3,000ft.
Estimated height of névé or snow field at the time of the last glacial epoch		8,000ft.
Present height of Mount Bogong, highest point of Victorian Alps...	6,508ft.	
Add waste by denudation in 210,000 years (say)	210	
		6,718ft.
Falling short of the névé or snow line of the last glacial epoch by about 1,282 feet		1,282ft.

[*] It is of importance to note here that Dr. Croll, impressed with the much greater eccentricity of the earth's orbit corresponding with this period, was fully convinced that a glacial epoch must have occurred at this time.

Surely the acceptance of the earlier epoch showing not only harmony with the causes which produced our earlier pluvial terrace drifts, but also satisfying all physical conditions for the initiation of glaciation, is a more reasonable conclusion to arrive at than to refer the glacial evidences to the later epoch, which would not satisfy physical conditions essential to the initiation of glacial action without involving the double assumption of an elevation and subsequent depression of 1,282 feet, for which there is no evidence whatever.

As regards the very doubtful evidence of intense glacial action in the shape of "boulder till" discovered by Messrs. Officer and Balfour in the lowlands of Korkuperrimal, situated nearly 200 miles to the east of mountains where alone in Victoria a permanent snowfield capable of yielding glaciers could be formed, it is evident that the potency of neither of the two great epochs of cycles of maximum eccentricity could be adequate to produce such intense effects, even if the lowlands of Victoria stood 5,000 feet above their present level.

As there is no proof of any kind to indicate such elevation and final depression at any time corresponding to these glacial epochs, *i.e.*, subsequent to the deposition of their Miocene leaf beds, it is probable that a mistake has been made in the inferences drawn from the facts. The certainty, moreover, that an elevation, not depression, of considerable extent has taken place since the upper Eocene or Miocene period is evidenced unmistakably by the Tertiary marine beds over a great portion of the lower levels of the Victorian territory on both slopes of the great dividing range. The supposed glaciation of the Korkuperrimal region is therefore quite anomalistic.

Sufficient illustration has now been given with respect to evidences bearing upon causes of glaciation, in Australia and Tasmania at least, to justify me in adopting for the present the following conclusions:—

(1.) That the glacier epoch of Australasia was probably comparatively mild in its effects, manifesting itself mainly by increased rainfall in lowlands, and by establishing local glaciers in the alpine regions of Southern Australia and Tasmania, and in greatly extending the spread of the existing snowfields and glaciers of the New Zealand Alps.

(2.) That probably, in Australia, the local glaciers of the Alps melted before reaching the 2,000 feet levels within the valleys which descended continuously from the elevated snowfields; and in Tasmania it is most probable that only on the western slopes of our western highlands was there sufficient precipitation to yield glaciers, any of which did not reach the sea, and probably were melted within their own valleys before reaching the 1,000 feet level.

(3.) That the date at least of our most refrigerated period was probably isochronous, and mainly caused by the maximum cycle of eccentricity of the earth's orbit with winter in aphelion, probably near to the beginning of our neogene period, say, 850,000 years ago.

(4.) That if the latter be true, it proves that the astronomical theory by itself (*i.e.*, without concurrence of geographical conditions) would not adequately account for the ice age of Europe and North America, nor for the absence of marked glacial phenomena among the earlier tertiary deposits of Europe at points of time concurring with the earlier cycles of eccentricity of the earth's orbit with winter in aphelion.

I do not expect that my conclusions will be accepted at present by many geologists who have already attained to crystallised views on the matter, but even these may be prepared to allow that, granting the premises assumed by me, my conclusions follow as a logical necessity.

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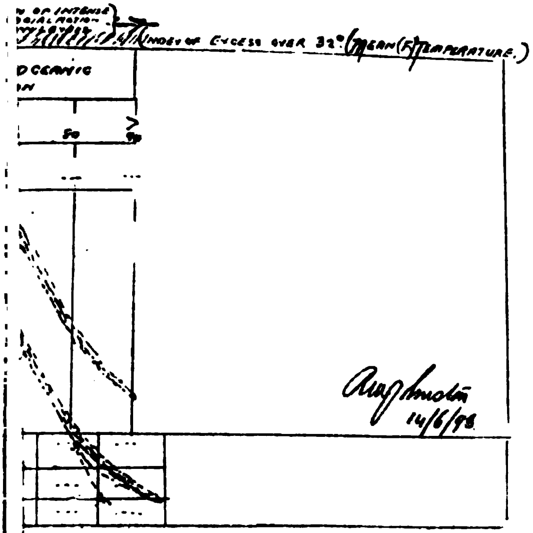

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NOTES ON THE GEOLOGY OF LAKE ST. CLAIR AND ITS IMMEDIATE NEIGHBOURHOOD, TOGETHER WITH OBSERVATIONS REGARDING THE PROBABLE ORIGIN OF OUR NUMEROUS TASMANIAN LAKES AND TARNS.

By R. M. Johnston, F.L.S.

Apart from the unrivalled beauty of the scenery, there is nothing particular in the *geological* features of Lake St. Clair and its immediate neighbourhood, which is not common to and far more perfectly represented by nearly all the elevated greenstone mountains and plateaux, which form the most familiar physiographic features of the greater part of Tasmanian landscape. The great elevated greenstone plateau of Tasmania—which occupies so large a portion of our island, and not only embraces the Lake St. Clair region, but also includes the greater portion of our notable mountain peaks and bosses—is of the most uniform and simple character, of which the following divisions, where perfect sections are disclosed, may be regarded as more or less *constant* and *typical*, taken in ascending order:—

General Characteristics.

1. *Base* either (*a*) slates, schists, limestones, or conglomerates of *Upper* or *Lower Silurian* age, as at Mount Tyndall, Eldon Peak, Eldon Bluff, La Perouse, Adamson's Peak, Ben Lomond on one side, and Mount Picton, or (*b*) *Archæan* or *Metamorphic* Rocks, as at Amphitheatre, Mount Gell, Mount Hügel, Mount King William, Little Sugar Loaf, Gould's Sugar Loaf, Mount Ossa, Mount Pelion, Barn Bluff, Cradle Mountain, Mount Manfred, and Du Cane Range.

2. *Permo-Carboniferous Rocks*, with their varied divisions of grits, conglomerates, mudstones, blue slaty shales, impure limestones; winged Spirifer, Productus, Stenopora, and Fenestella Zones; Lower Coal Measures (Tas.), with
    Glossopteris, *Gangamopteris*, and *Nœgarathiopsis;* common throughout Eastern Tasmania.
Middle Coal Measures (Tas.), with
    Gangamopteris and *Vertebraria*, as on Ben Lomond, Mount Cygnet, and slopes of Mount Wellington.

3. *Lower Mesozoic Sandstones*, with *Vertebraria* and remains of *ganoid fishes*, as on slopes of Mount Wellington and Mount

Pearson, and common elsewhere throughout Eastern Tasmania.

4. *Upper Mesozoic Sandstones, Shales, and Upper Coal Measures* (Tas.) with *Zeugophyllites, Thinnfeldia, Sphenopteris, Pecopteris, Neuropteris, Alethopteris, Odontopteris, Tæniopteris, Cyclopteris, Baiera, Salisburia, etc.*, as at Ben Lomond, Mount Nicholas, Fingal Tier, Mount Gray, slopes of Mount Wellington, and probably Mount Pelion and Coal Hill, and common elsewhere throughout Eastern Tasmania.

5. *Greenstones*—Massive, Core Crest (?), or Covering Cap (?)—associated with mesozoic coal measures, and occupying the summit of Great Plateau and of most of our mountains in Eastern Tasmania.

6. *Occasionally lignites and Tertiary leaf beds*, as on Magnet Range.

7. *Occasionally (in patches) olivine basalt sheets*, as at Bronte, River Nive, and Lake Sorell.

While I cannot but compliment Mr. Officer for his interesting notes on the geology of the Lake St. Clair region, and for the general accuracy of his observations, so far as they go, it is unfortunate that his lack of acquaintance with the literature of Tasmanian Geology should have led him to give so bald an account of the most familiar geological features of a region which is classic to the local observer as the field wherein one of Tasmania's ablest geologists (Mr. Charles Gould, during the years 1860, 1861, and 1862) accomplished his best work as an explorer, geographer, and geologist. Even Mr. Officer's geological sketch, with its details of lake-depth, mountain and ravine, would not now be possible, were it not almost entirely based upon the earlier elaborate investigations of Mr. Charles Gould, covering a period of two or three years, and aided by a field staff of about 32 men. This much-undervalued observer not only gave us all our existing routes and tracks in this western region, but, owing to his long and ably conducted explorations, he gave us, in his geological and physiographical maps and vertical sections of 1860 and 1862, the knowledge of all the physiographical features and principal geological characteristics which we are possessed of at the present moment, and which form, for this region, the base of the delineations on our latest survey maps, which are partly reproduced by Mr. Officer. During my own later explorations in this region, I could only, by the aid of more definite palæontological data, *confirm* what Gould so well described and delineated over thirty years ago. Nor, in spite of some adverse conceptions of Mr. Officer, so far as I am concerned, as regards the still doubtful age of the greenstones of the Great Plateau, can I admit any novelty of conclusion formed by him; for, in this respect, he simply follows and adds weight to the original conclusions of Messrs. Gould, Milligan, and Strezelecki, against whose judgment, as to age of greenstone, I have always felt myself to be in an uncongenial atmosphere of opposition, even when that opposition, as so frequently expressed by me, is both very doubtful and only at most *tentative.* This attitude on my part is only natural, when it is considered that, in my ideal section from Dry's Bluff to George Town, published in this Society's Journal* twenty years ago, I then followed Gould and Strezelecki, in regarding the greenstone of the Great Plateau as younger than the Permo-Carboniferous and Mesozoic sedimentary formations. Owing also to Mr. Officer's imperfect acquaintance with local sources of information relating to Tasmanian Geology, he has, in his small chart of Lake St Clair, unwittingly, reproduced a *fac simile of a fragment* of a geological "Map of a portion of Western Tasmania,"† explored during the summer of 1860 by an expedition under the command of Charles Gould, B.A., F.G.S., Government Geologist (lithographed and coloured by F. Dunnett, of Hobart). That it simply reproduces a fragment of the geological and physiographical details of this region of the west of Tasmania as originally mapped by Gould, is best appreciated when I mention that this scarce, but locally well-known, coloured geographical map of Mr. Gould, embracing the portion mapped and coloured by Mr. Officer, and agreeing with it perfectly in all essentials, covers an area of about 2,500 square miles, situated between Cradle Mountain and the Mount Murchison region in the north, and between Lake St. Clair and the Mount Lyell region in the south. When I state that Mr. Officer's chart is a less perfect delineation or *fac simile* of a portion of the region, covering at most 234 square miles of the south-eastern portion of the area embraced in Mr. Gould's more perfectly detailed geological map (that is, only 9·36 per cent. of the area) we may more easily appreciate how far the map of Mr. Officer falls short of the more extended original map of 1860, while, for obvious reasons, it also compares unfavourably with the latter in exactness of physiographical and geological definition. I say this is unfortunate, because, were it not for the original elaborate and comprehensive geological map of Mr. Gould, Mr. Officer's smaller chart of a portion of the region would, unquestionably, be considered a most meritorious delineation, regarded as the result of the unaided observations of a geologist who had briefly examined the country for the first time.

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*Proc. Roy. Soc. of Tas., Aug, 1872 "Composition and extent of Tertiary beds in and around Launceston."

† Scale, 2¼ inches to the mile

LACK OF PALÆONTOLOGICAL EVIDENCE AS TO THE AGE OF THE COAL HILL COAL MEASURES AND ASSOCIATED SANDSTONES.

There is, however, another matter of great local importance which Mr. Officer's paper reminds us of, viz., the doubtful age of the coal measures which we know exist at Coal Hill, and the lack of knowledge regarding the positive existence of Lower and Upper Mesozoic formations succeeding the Permo-Carboniferous mudstones, of which we have here and elsewhere along the crests of the Great Plateau the most abundant evidence. Had Mr. Officer been more perfectly acquainted with our local wants in this respect (see "Geol. of Tas." p. 164), I am sure his labours and observations would have been more profitable to science, as well as of more lasting satisfaction to himself. Let us hope that he may yet be encouraged to return to this interesting out-of-the-common track region, and direct his observations rather to fill up the *blanks* in our knowledge regarding the doubtful age of the Coal Hill coal measures, and also help us in discovering positive evidence (stratigraphical and palæontological) of the presence, or otherwise, with boundaries, of the rocks of Mesozoic Age of both upper and lower horizons, which are so familiar to us in similar situations in the more eastern elevated greenstone plateaux. Without palæontological evidence we can proceed no further at present, and it is unfortunate in this respect that Mr. Officer's observations afford no light whatever.* As regards certain new aspects of portions of the greenstone plateau, my own observations during the last four or five years have again independently disposed me to regard with more favour the possible later or Post-Mesozoic age of the greenstones of the Great Plateau and elsewhere. My difficulty still exists as regards the apparent older greenstones lying between Blackman's Bay and Adventure Bay. But I take this opportunity of acknowledging that my continued failure to detect the remains of undoubted greenstone rocks among the abundant erratics and derived conglomerates in our mudstones, together with the undoubted similarity of character of supposed older and later greenstones, have for the last year or two weighed strongly in my mind in favour of the later age of all our typical diabasic greenstone rocks, and I should not now be surprised in the least if reasons should soon be forthcoming which

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*It would be interesting to learn how Mr. Officer arrived at the knowledge that the whole of the Sandstones mapped by him as *Carboniferous* are really so. He does not support this conclusion by a single reference to the characteristic fossils, by which means alone can such a conclusion be accurately arrived at; for the Sandstones of Permo-Carboniferous Age and Lower Mesozoic Age in Tasmania are so similar in lithological characters, that references so hazarded are pure guesswork.

might reconcile my judgment with the apparently strong opposing evidences presented by the extent, mass, positions, and continuous relationship of the greenstone rocks underlying the mudstones between Blackman's Bay and Adventure Bay in South-Eastern Tasmania. Mr. Montgomery's and Mr. David's reasonings, I confess, have also had much weight in disposing my mind to contemplate a result of this kind. Let me be just to myself, however, by quoting my earlier remarks on this important question. In commenting upon the *pros* and *cons* relating to the age of the greenstones, I have always accepted the fact that the larger portion of the greenstones of the lower levels were younger than the Upper Mesozoic coal measures, although I was, and am still, doubtful of the age of the massive greenstones of the more elevated regions, and such was, and is, my tentativeness of opinion, that, in my paper on the Geology of Bruni, read before this Society on April 13th, 1886, I stated—"That the opinions advanced by me have merely the force of probability, in my mind, from which all doubt has not yet been wholly removed;" and again (p. 8), "I am only anxious for the truth of my opinions, and therefore shall always be prepared to modify them in accordance with the weight of available evidence." As yet I have not heard of any satisfactory reasons which would account for the position and relationship of the Bruni and Blackman's Bay greenstones in such a manner as would favour an origin more modern than the Upper Palæozoic rocks, which appear to have been quietly deposited upon their upper irregular surfaces. I have considered the possibility of lateral thrust between the bedding on a gigantic scale, but there are still many positive objectious lying beyond, which at present prevent me from accepting this solution.

THE REGIONS IN THE NEIGHBOURHOOD WHERE THE FORMATIONS AROUND LAKE ST. CLAIR MAY BE STUDIED MOST ADVANTAGEOUSLY.

By confining his observations to the immediate shores of the charming Lake St. Clair, and to the romantic valleys of the Cuvier and Narcissus, Mr. Officer lost no advantage, so far as the lover of the picturesque is concerned; but, so far as the profitable study of the particular geological formations is concerned, he could not have chosen his field of observation more unfortunately. It is quite possible that if Mr. Officer could have obtained a view of the complete series of the rocks from the actual bed of Lake St. Clair, which is buried as much as 552 feet beneath the surface of its water level in the immediate vicinity of Mount Olympus, he might obtain a fair knowledge of the character and sequence of the typical rocks of this interesting locality. But although

Mr. Gould assures us that the Metamorphic rocks (not carboniferous sandstones, as in Mr. Officer's chart) form the deepest bed of the lake, which he had sounded so carefully in every direction in 1860, it is impossible from *direct* observation to confirm or disprove his statement. It is when we leave the Lake and its affluents (the Cuvier and Narcissus), and traverse the region of mountain and valley, beginning with that of the Lakes Dixon and Undine, and thence proceeding westward, along Gould's well-known section, by way of Mount Gell, Coal Hill, Gould's Pyramid, Rocky Hill, Camp Hill, Last Hill, and Eldon Peak, across to North Eldon, that we have a fairly complete glimpse of the grand range and sequence of the varied and interesting geological formations of the Western Highlands of Tasmania. The region of Lake St. Clair proper, with the valleys of its northern affluents, the Cuvier and Narcissus, disclose the *merest fragment* of this splendid sequence of rock formation; a fragment, moreover, which can be studied with greater advantage and in much greater perfection within one mile of the City of Hobart, and nearly everywhere in the more accessible regions of the east.

I can say no more of this fragment of Tasmanian geology—which, however, embraces all our rich and interesting Permo-Carboniferous and Mesozoic formations—than has been so fully described by me already in numerous geological papers to this Society, and whose study has occupied my own close attention for a period of nearly a quarter of a century. The fact that in my work on "The Geology of Tasmania" alone I have devoted 123 royal quarto pages to its history, accompanied by numerous plates and sections, and illustrated also by over 230 figures of typical fossils, is surely sufficient evidence that it has not been neglected, and that we have acquired a considerable knowledge of its leading characteristics. Between the North Eldon River bed and Lake Dixon valley, however, we have, as shown in accompanying section, a grand development of rocks, embracing probably a complete series of all the older formations from the *Archæan* to the *Upper Silurian*, and possibly also—in the upper conglomerates of some of the mountains, such as Mounts Lyell and Owen—the equivalents of the Devonian of other countries. The general character and relationship of this grand series of rocks, as disclosed by Mr. Gould's section, part of which I have myself verified from palæontological and lithological data, may be summarised as follows :

1. Row or Granite Tor—*granite axis.*

2. Row Tor, across the Murchison Valley to North Eldon River, *metamorphic schists, etc.*—apparently devoid of fossils.

3. North Eldon River, across Eldon Peak, Camp Hill, and Rocky Hill to Inkerman River: base Lower

Palæozoic rocks; those most apparent being of Upper Silurian Age, and in the Eldon Valley, Princess River, consisting largely of clay slates, mudstones, and schistose, sandstones with thin quartz reefs, and in certain beds, richly fossiliferous, the following forms are especially prolific:—*Calymene*, *Pentamerus*, *Orthis*, *Strophomena*, *Spirifera*, *Atrypa*, *Lingula*, *Rhynchonella*, *Leptaena*, *Loxonema*, *Favosites*, encrinital stems, etc. Unconformably lying upon these we have in succession, as on Eldon Peak, Camp Hill, Rocky Hill, etc., in ascending order:—

I. Upper Palæozoic grits, conglomerates, and mudstones, with the usual abundance of winged spirifers *Productus*, *Terebratula*, *Strophalosia*, *Aviculopecten*, *Pachydomus*, *Sanguinolites*, *Streblopteria*, *Avicula*, *Palæarca*, *Tellinomya*, *Inoceramus*, *Pterinea*, *Notomya*, *Platyschisma*, *Orthonata*, *Conularia*, *Goniaites*, *Stenopora*, *Protoretepora*, *Fenestella*, *Encrinites*, etc.

II. Thick bedded sandstones, shales, and coal, as at Coal Hill, Mount Gell, etc., of which no fossil evidence has yet been obtained, but which may possibly embrace the *Lower Coal Measures* with *Glossopteris*, *Gangamopteris*, and *Nœggarathiopsis*; the *Lower Sandstones of Mesozoic Age*, with *Vertebraria* and ganoid fishes; and the *Upper Coal Measures Shales and Sandstones*, with *Zeugophyllites*, *Baiera*, *Pecopteris*, *Spenopteris*, *Thennfeldia*, *Neuropteris*, *Tæniopteris*, *Salisburia*, *Pterophyllum*, etc.

III. Massive cap (?) or elevated cores (?) of diabasic greenstones—the most characteristic feature of all our mountain peaks, bosses, and plateaux, from Mounts Tyndall and Dundas on the west, to St. Patrick's Head and La Perouse on the east.

IV. Inkerman River, across the spurs of Gould's Pyramid, Alma River, Mount Gell to valley of the Dixon and Undine; *base*—Metamorphic schists quartzites, gneiss, conglomerates, etc., with overlying rocks, as on Eldon Peak, at Mount King William, Mount Hügel, and Mount Gell; and on intervening ridges and peaks, as Rocky Hill, Gould's Pyramid, and Coal Hill, the usual sandstone shales, grit, etc., whose age may be Upper Palæozoic or Mesozoic, or include both; but in the absence of palæontological data, cannot now be determined.

Apart from the Brachiopod sandstones, Clay-shales, Hydromica-schists, and more recent conglomerates further west, between Mount Lyell and the Tertiary Lignites and Leaf Beds of Macquarie Harbour, this region affords a grand field for original investigation in the future, as at present we have only a very bald view of its history and stratigraphic sequence. It is here that the Tasmanian geologist in the future may expect to win fresh laurels, rather than in the immediate vicinity of Lake St. Clair, just lying beyond its most easterly limits, *i.e.*, across the great eastern and western watershed-dividing ranges of Mounts Hügel and Rufus. Southward across the Frenchman, Gordon River, Arthur Ranges, towards Port Davey, a still more interesting region awaits systematic exploration; for all that we know at present is, that the whole region is similarly occupied, mainly by the *Lower Palæozoic* and older *Metamorphic* rocks, whose geological history is still, practically, a closed book, and even its exact physiographical features are far from being perfectly delineated on our charts.

ORIGIN OF THE NUMEROUS LAKES, TARNS, AND LAKELETS OF THE GREAT PLATEAU OF TASMANIA.

While I am fully convinced that a large number of our small lakes and tarns, mostly carved out of the harder crystalline rocks, towards the mouths of the Alpine Valleys of our Western Highlands leading from the Great Plateau (such as Lakes Undine, Dixon, and Augusta), have been originated mainly by the agency of glaciers and their terminal moraines, I have, from long observation, arrived at the conclusion that our larger lakes on the higher levels of greenstone plateau—such as Lake St. Clair, Lake Sorell, Lake Echo, Lake Arthur, and Great Lake, together with innumerable lakelets and lagoons on the upper levels—have been mainly determined by the original irregularities of surface, produced partly by the anastomoses of successive flows of greenstones during their eruption, and partly by the unequal contraction due to lack of homogeneity of the cooling surfaces of the more massive horizontal flows of greenstone magma, which are so characteristic on the mountain plateaux of Tasmania, and which cover continuously, or in an anastomosing network of ranges, so large a portion of the superficial area of Eastern Tasmania. This conclusion has again and again been forced upon my mind by the closer study of our upland lake systems, as it seems to account satisfactorily for all the known facts; and, moreover, it is in harmony with the views of leading physicists when contemplating the causes which produced the initial and universal irregularities of surface on our globe, and which in their turn determined the limits of land and sea during the later epoch in its history, which marked the stage of change from the expansive free gaseous envelope of vapour to precipitation and condensation from cooling and gravitation, in the form of lake, river, sea, and oceanic waters, within the limits determined already, by irregularities of the surface of the earth's crust.

A diversified distribution of the original surface magma of our globe is assumed with good reason by Mallet J. D. Dana,* Professor Hennessy, Archdeacon Pratt, Sir Archibald Geikie, and many other eminent physicists and geologists, as a primary condition; and this primary condition, owing to the unequal rates of cooling, and differences of density of different masses of magma, is assumed to be the initial factors in producing elevated and depressed surfaces, including cup-shaped basins. The denudation of agencies such as the mobile gravitating force of water, only come into play at a subsequent stage, so that the older caused irregularities of surface, to a large extent, initiate and govern the direction and local intensities of subsequent denuding agencies.

In accounting for the origin of Alpine lakes generally, by the Glacier Theory—according to Ramsay's view, which, during the first quarter of this year, has again been prominently brought before our notice by a discussion of the subject in the pages of *Nature* by Mr. T. G. Bonney,† the Duke of Argyle, ‡ and Dr. Alfred Wallace § it would seem that the fascinations of Compte's "Law of the Simplest Hypothesis" have a dangerous tendency to promote a retrograde movement in geological science; and that some of her most brilliant exponents are not altogether mail-proof in resisting their fascinating influence when the charmingly disguised errors of *simplicity* of causation, by their aid, are championed in opposition to the truer, though, perhaps, less attractive *complexity* of variable or combined causes. In geological science, as in economic science, there is ever a danger of mutilating a complex truth for the sake of erroneous simplicity; and the bed of Procrustes was but a feeble engine of distortion or mutilation, as compared with all simple or *specific* hypotheses of causation specially devised to embrace somehow all effects, notwithstanding that the points of similarity in the latter may only appear to be of congeneric value, and not conspecific.

Professor Marshall, in his recent work on "The Principles of Economics" (Methods of Study) has given us earnest warning of this danger to all students of complex problems of science; and has shown that the "Physical sciences made slow progress so long as the brilliant but impatient Greek genius insisted in searching after a *single basis for the explanation of all physical phenomena*; their rapid progress in the modern age is due to a breaking up of broad problems into their component parts. There is no doubt an underlying unity in all the forces of nature, but whatever progress has been made towards discovering it has depended on knowledge obtained by persistent specialised study, no less than an occasional broad survey of the field of nature as a whole," and accordingly, with Mill, he approves of another of Compte's sayings, that "a person is not likely to be a good economist (might we not add also for local application, *a good geological specialist*) who is nothing else." Although these observations are directed to quite a different matter, the central idea may yet be applied with advantage to all who are apt to be carried away by the fascinations of simple universal hypotheses of causation, as accounting for complex though superficially similar effects. I am of opinion, therefore, that the effort on the part of some brilliant geological investigators to account *generally* for the origin of Alpine Lake basins by reference to the Glacier Theory is a retrograde movement and a mistake. It may account for a large number of lake basins, but if all previous observations are not a blunder, it cannot account for all lakes, even in Alpine regions. Every geologist who desires to avoid imparting error into his inferences from local facts of observation, must therefore rigidly guard against deceptive general hypotheses, lest they should unconsciously bias and disturb his mind in making correct interpretations of observed facts; and hence each lake basin, wherever situated, is best studied apart from all others on the basis of local evidences. This method, moreover, does not exclude the Glacier or any other particular agency, regarded as a cause. Apart from one's own experience in support of this view, we have the best positive evidence of its truth in the writings of all authors of Geological Text Books, whose imagination is kept under stricter control, partly by the feeling that they are more responsible for the teaching imparted by them, and partly by the circumstance that in giving the outline of any particular subject, they are led to review all the varying circumstances and conditions, and, in unsettled questions, to give the facts upon which they are based, in order that the student may be properly equipped to grapple with similar difficulties when they appear to him.

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*The fact that the Continental and Oceanic areas were determined in the first cooling of the globe signifies that in the cooling or radiation of heat into space, there were areas of greatest and least contraction. This difference in cooling and the resulting level of the surface must have been owing to some difference of quality or condition in the material. (Dana's "Manual of Geology," 3rd edition, 1879.)

† *Nature*, p. 341 (Feb.). ‡ *Ibid.*, p. 369. § *Ibid.* (March) p. 437.

Sir Archibald Geikie's luminous writings and observations alone suffice to overthrow the "ONE CONDITION, ONE CAUSE" theory of lake origin. In his text book (p. 927) he gives a most true and lucid account of the various causes which are known to have produced lake basins, and may be briefly summarised as follows:—Lakes may be formed in several ways:—

1. By subterranean movements, as in mountain-making, and in volcanic explosions, and as in the subsidence of the central part of a mountain system, which might conceivably depress the heads of valleys below the level of the original outflowing channel of stream, and as in the cup-like basins of extinct craters. Types of the latter are exemplified in Australia, by the Blue, Middle, and Centre lakes of Mount Gambier, and possibly some of the lakes of the Great Plateau of Tasmania.

2. By ponding back of streams by lava. Type, Lake Aidat in Auvergne, and probably Lake St. Clair in Tasmania. The latter, however, can only partly be the result of this cause, for its great depth of 592 feet, in a trough of older rocks lying *below* the igneous flows, the igneous ponding flow being so much above its deep bed, the present head, now even 180 feet below the lake surface, has by depression of the head of the valley, mainly aided in the formation of its great depth of water bed. The flow of greenstone which closes the mouth of the Lake, and through which its affluent the Derwent cuts its shallow course, would not, by itself, account for its present great depth; nor would glacier erosion account for all its peculiar characteristics.

3. By subsidence of surface, caused by the dissolution of rock salt, limestone, etc., such examples of the former occur in the Peak caverns of Derbyshire, grottoes of Anteparos and Adelsberg, and the vast labyrinths of the Mammoth Cave, Kentucky, and Salt Pans, Tasmania. Examples of the latter form are found frequently as small lakes and ponds in Tasmania, as at the Circular Marshes and Ilfracombe.

4. By the original irregularities of surface, produced by the irregular anastomosing flows, and unequal cooling of massive unhomogeneous igneous rock, as on the Great Plateaux of Tasmania; combined, probably also, with violent and abrupt alterations of level during the cataclysmic upheavals, which raised the rocks bodily, as on Ben Lomond, Mount Wellington, Great Plateau, and many other mountain table-lands, to a height of about 2,500 feet above their former levels. Geikie (p. 925, Text Book) states that most of the great table-lands of the globe seem to be platforms of little disturbed strata, either sedimentary or volcanic, which, as in the case of most of the elevated greenstone plateaux of Tasmania, "have been upraised bodily to a considerable elevation."

This cause, therefore, accounts most satisfactorily for the greater number of our elevated Tasmanian lakes, such as

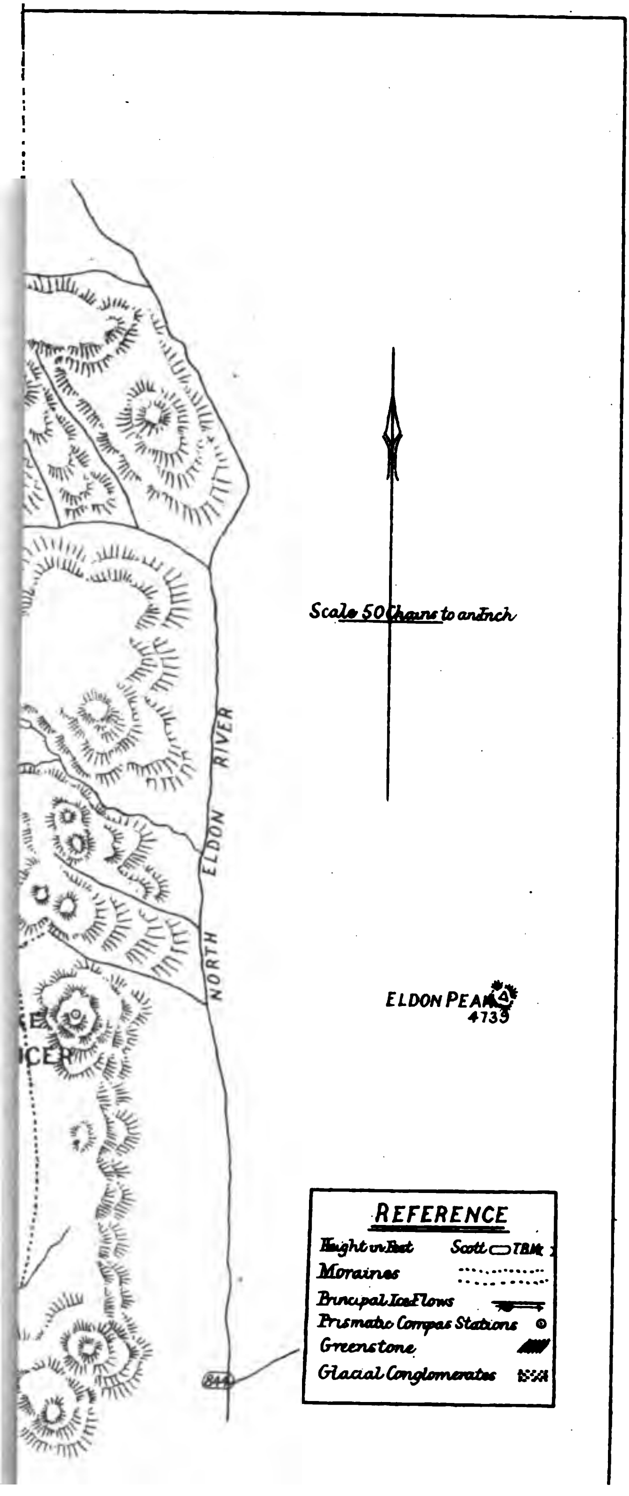
Lake St. Clair, Lake Echo, Lake Arthur, Nineteen Lagoon, Lake Sorell, Lake Crescent, and Great Lake on Great Plateau, and Lake Youl on Ben Lomond.

5. By the irregularities of surface caused by ice sheet movements, as in the northern parts of Europe and North America; leaving, on the retirement of the ice, clay and mound enclosed hollows, forming, subsequently, numerous tarns and lakes.

6. By the irregular erosion of valley systems, leading from high table lands and mountain chains, by former glaciers, of which, Lakes Undine, Dixon, George, Rufus, Dora, Spicer, Beatrice, Augusta, Edgar, and innumerable other lakes and tarns in similar situations in Alpine Valleys in Tasmania afford good local examples. Dr. Wallace has attempted to show that glacier regions and lakes and tarns are constant concomitants, and by inference these are desired to be regarded as cause and effect. But in the light of the preceding review of the mutability of causation, there is surely a better reason to be given for the prevailing concomitance in the higher latitudes of Europe and North America, and the absence of numerous lakes in lower latitudes, except, as he allows, in *volcanic regions*. May the absence of lakes in the lower levels of low latitudes be not better accounted for, partly by the absence of precipitation, as in desert regions, and partly by rapid evaporation exceeding precipitation in other lower levels of warm regions?

On the other hand, as igneous rocks are also largely characteristic of the higher altitudes of all great mountain chains, peaks, and plateaux of glacier and other regions, may not be irregularities of surface produced on the surface of such rocks in glacier regions, caused by an unequal cooling, anastomoses of flow and violent alterations of level by upheaval, account for a larger number of the lakes in glacier regions than even the admittedly numerous examples which may be fairly referred to glacier erosion alone?

These are considerations well worthy of close attention, and whatever differences of opinion may still exist, it is hoped that the experience gained by the study of the numerous lakes of Tasmania may be of some service in arriving at a true conception of the whole subject.


Scale 50 Chains to an Inch
NORTH ELDON RIVER
ELDON PEAK
4739
KE
ICER
844
REFERENCE
Height in Feet
Scott
TBM
Moraines
Principal Ice Flows
Prismatic Compass Stations
Greenstone
Glacial Conglomerates

DISCOVERY OF GLACIATION IN THE VICINITY OF MOUNT TYNDALL, IN TASMANIA.

By T. B. Moore, F.R.G.S.

(Map.)

A most important and extremely interesting discovery of glaciation was made by Mr. E. J. Dunn, F.G.S., of Victoria, in the first week of October, 1892, on the high plateau in the vicinity of Lake Dora, Tasmania. Having been with Mr. Dunn at the time of his discovery, and as it was his intention to write on the subject, I now wish to record in the proceedings of our Royal Society the result of a more extended search made by me on the high peaks and surrounding tableland, and illustrate the most important features of the glacial action on the accompanying sketch map compiled from prismatic compass bearings. The Tyndall Range and Mount Sedgwick have been the principal seats of the prehistoric glaciers; respectively these mountains are about thirteen (13) and nineteen (19) miles in a direct line from the town of Zeehan, and twenty-two (22) and nineteen (19) miles from the port of Strahan. They rise 1,500ft. to 1,600ft. above an elevated plateau, on which are situated Lake Dora and numerous other lakes and tarns at an altitude of 2,400ft. above the sea level. The plateau is drained on the north by the Anthony River, a tributary of the River Pieman, on the west by the Henty River and its tributaries, and on the east and south by the head branches of the King River. The formation of the higher land is a quartzose conglomerate, probably Devonian. A band of silurian schist, overlaid in places with a schistose conglomerate over a quarter of a mile in width, adjoins on the east, to which I shall allude in this paper as the Devonian conglomerate, and further east, as far as the North Eldon River, close-grained quartzites and conglomerate occur. The summit of Mount Tyndall beautifully illustrates the direction in which the glaciers have retired. The Devonian conglomerate rock shelves off at different points of the compass, is worn perfectly smooth, and within 20ft. of the summit the rock is polished and striated. The glaciers descending from the higher peaks have flowed in many directions down the numerous valleys, in their course beautifully polishing, grooving, striating, and moutonnising the Devonian conglomerate, deeply grooving and furrowing the softer silurian schists, and scooping out the rock basins now forming the present lakes and tarns; then in places rasping over hard quartzite and conglomerate ranges 400ft. and 500ft. higher than the lower land over which they have travelled, indicating on all rocks the direction each flow has taken by the striæ and the erratics and perched blocks left behind. The largest erratics and blocks are composed of Devonian conglomerate. Some examples are 20ft. high by about 15ft. broad and long respectively, many are planed and striated splendidly, and are often found forming segments of circles at the edge of the morainal matter, or scattered in confused masses over the moraines. Mount Sedgwick (4,000ft.) is even more interesting than the Tyndall country. Greenstone forms a cap to the mount, 800ft. to 1,000ft above the lower surrounding Devonian conglomerate; naturally the trap rock has weathered, yet deep grooves and furrows are perceptible to within a short distance of the summit. (Mount Dundas is the only other eminence in the West Coast range capped with a similar formation, but without signs of glaciation.) The elevated country round Mount Sedgwick, especially to the east, has been swept bare, and, with the exception of a few small boulders, all other morainal matter has been carried down the steep slopes and river valleys. The quartzite and conglomerate rocks show the striæ polishing, etc., similar to those round

Mount Tyndall. At an elevation of 3,500ft. above sea level, adjoining the greenstone on the south-east side of the mount, I was pleased to discover a bed of glacial conglomerate containing coal measure fossils; the pebbles are scored in all directions, and many beautifully polished. The conglomerate is composed of rocks quite foreign to the country granites, slates, porphyry, etc., and as they occur at such a high elevation, embedded together, intermixed with carboniferous fossils, and the pebbles scored before the mass was consolidated, there is not the slightest doubt that the conglomerate has been formed from the *debris* deposited by floating ice when the land was under water. This also points to the fact that the deposit was laid at a previous period to the epoch of the land glaciation. A small accompanying chart shows the position and extent of the bed of conglomerate, which, at the junction of two small streams, rises in a cliff 50ft. high, the greatest depth observable. The principal ice flows have been from the N.E. and slightly north of east. As all the chief features are depicted on the chart, and the scorings of the rocks, etc., illustrated by specimens, I have avoided a detailed description, but before closing would like to briefly describe the moraines. Some rise from two to three hundred feet above the lower valleys, those to the west of Lake Margaret are the most extensive, and it is in these moraines that the only scored small pebbles and rocks were found. Montgomery's Moutonnées, named after our much loved Bishop, is a spur, the rocks beautifully moutonnized, grooved and striated with perched blocks resting picturesquely here and there, and before Sir Robert Hamilton, our late Governor and President, left Tasmania, I received permission from him to name "The Hamilton Moraine," the largest discovered. The point marked Dunn's Boss is the best illustration of a roche-moutonnée met with, and is named after the discoverer of glacial action in Tasmania. Mr. Dunn named most of the prominent features in the part he visited, therefore I have not encroached upon his domain. The extremely hard ice-worn country rocks, grooved and striated on the plateau to the highest peaks of the mountains, indicate that a vast sheet of ice of great thickness (probably 1,000ft.) has covered this region in a colder period. As far as I have observed, the principal flows have been to the east and south, the striæ being more discernible, and the morainal matter being carried into the lower lands; to the west and north the ice has melted away before reaching a great distance, leaving the morainal matter closer to the high points of the range, and in these directions the striations are not so marked. As far back as 1883, in a report to the Government of an exploration to the West Coast, I pointed out the probable existence of glaciation on the Eldon Peak and Mount Gell, owing to the erratics and accumulations of boulders met with in the Collingwood Valley, and perched blocks found resting on the higher hills, and now the glacial action is proved to exist beyond doubt. From personal knowledge, morainal matter is scattered over a wide area on the West Coast, and now it will not be difficult to trace the course the vast sheets of ice have travelled, and before many weeks have elapsed I hope to supplement this paper with an account of other discoveries of glaciation remote from the locality described. Two names occur on the chart which are not yet officially sanctioned, viz., Mount Geikie and Lake Mary. It will be observed that Mount Geikie is a distinct mountain from Mount Tyndall (name conferred by the Hon. J. R. Scott), is separated by water channels, and is 75ft. higher.

A few of Mr. J. R. Scott's heights are recorded on the chart marked thus (▭), my own so ( ).

List of specimens sent to illustrate the rock striation, etc., for the Museum:—

No. 1. A series of polished, grooved, and striated quartz site.

No. 2. A series of polished and striated conglomerates.
No. 3. Polished corner of quartzite.
No 4. Striated hematite from a lode 60 feet wide.
No. 5. Planed "erratic."
No. 6. Grooved greenstone from Mount Sedgwick.
No. 7. Polished and striated pebbles from Devonian conglomerate (No. 2 series).
No. 8. Glacial conglomerate, containing coal measure fossils, Mount Sedgwick.
No. 9. Polished pebbles from glacial conglomerate.
No. 10. Scored pebbles from glacial conglomerate.
No. 11. Sheared pebbles from Devonian conglomerate.
No. 12. Scored morainal matter, near Lake Margaret.

SUPPLEMENTARY NOTES.

DISCOVERY OF GLACIATION IN TASMANIA.

Mr. T. B. Moore, F.R.G.S., contributed some supplementary notes to his paper, read at the April meeting, on "The discovery of glaciation in Tasmania." He said:—During a recent trip from Mount Lyell to the extreme southern termination of the West Coast range a few signs of glaciation were discovered, the most important being in the neighbourhood of Mount Lyell, where the Linda Valley is covered with a layer of morainal matter, and in the sidling cuttings of the horse track I picked up numbers of scored pebbles. It will be interesting for the Linda gold-mining shareholders to know that the deep ground hydraulically sluiced on their sections is nothing but a huge mass of morainal matter; many of the large boulders and smaller accumulation of stones of a soft nature are beautifully scored. It yet remains to be proved whether the glaciers have travelled from Mounts Sedgwick or Lyell; from the appearance of the latter mountain in the distance, I should say their first start was made there—travelling down the escarpments at the head of the Linda River and wearing away the soft hydra-mica schists and pyrites beds, which, in all probability, continue northwards from the Mount Lyell Co.'s property. By this erosion a quantity of auriferous pyrites has by degrees been brought down in the morainal mass carried by the ice, and has been principally deposited at the Linda Co.'s land at a point where the gullies are confined before they widen out into the Linda Valley. Along the base of the eastern slopes of Mounts Owen, Huxley, and Jukes large moraines extend into the lower land, and morainal matter is scattered over the broad valley of the King River. After the King River breaks through the range between Mounts Huxley and Jukes the morainal matter extends south to the end of the latter mountain. The boulder accumulations have a strike either to the south or south-east, showing that the ice flows have travelled in these directions, which are similar to the principal courses in the vicinity of Lake Dora. The most extensive glaciation has taken place at Mount Owen, where a large moraine forms a connecting ridge between that mountain and the Thureau Hills. The northern extremity of the Thureau Hills is well glaciated, as shown by the ice-worn rocks and large greenstone boulders perched high upon their slopes. Six years ago I was on the tops of all the mountains mentioned, and found on the summits of Mounts Owen and Jukes small tarns similar in character to those at Mounts Tyndall and Sedgwick. Yet, as far as I have observed, the locality of the first discovery has the best and most extensive illustrations of land glaciation in all its forms. On my recent trip only the summit of Mount Darwin was examined. Here I did not observe any distinct signs of ice action—the rocks are rounded, but no striæ visible.

THE GEOLOGY OF THE LAKE ST. CLAIR DISTRICT, TASMANIA.

GRAHAM OFFICER, B.Sc.

(Maps.)

In the following paper an attempt is made to give some account of the main geological features of the district about Lake St. Clair. The observations were made during a recent visit to the lake by a party, including Professor Spencer, of Melbourne University, myself, and several others. Owing to the inclement weather we experienced, we were unable to make as extensive observations as we would have wished, and the present account does not purport to be more than a geological sketch.

Lake St. Clair is situated on the great central greenstone plateau of Tasmania. This plateau, according to Mr. R. M. Johnston, "preserves a general rugged or undulating level of about 4,000 feet altitude, and its higher bosses and peaks and its valleys do not vary much more than 1,000 feet above or below this uniform level." Lake St. Clair, the queen of Tasmanian lakes, lies near the western boundary of this plateau, and a little to the north of the central part, its northern shore being cut by the parallel 42° S. lat. Its elevation above the sea is about 2,400 feet. It lies in a long, deep, narrow valley, bounded on the east by the Traveller Range and its offshoots, Mount Ida, and the rugged mountains between it, and the Ducane Range, and on the west by Mounts Olympus, Byron, and Manfred. The length of the lake is about 11 miles, while its greatest breadth is about 2 miles. A depth of 590 feet is recorded.

At the north end the valley extends to the foot of the Ducane Ranges, some 10 miles beyond this extremity of the lake. The southern shore shelves up to a succession of low greenstone ridges and button-grass flats. The shores of the lake are remarkably regular, and at this end (southern) occur the only indents of importance, viz., Cynthia Bay on the W. and the lake basin on the E. The latter is almost land-locked. From it the Derwent starts on its way to the south. The lake is fed by numerous streams and torrents, the principal ones being the Narcissus (Hamilton) on the N., flowing from the Ducane Mountains; on the E. a stream from Lake Laura and another from the mountains behind Mount Ida, while Cynthia Bay receives the Cuvier. The latter river rises from Lake Petrarch, a small sheet of water just under Olympus, on the opposite side from Lake St. Clair, and about 560 feet, according to our aneroid, above it. The Cuvier flows down a broad, undulating valley known as the Vale of Cuvier. This valley runs in a S.E and N.W. direction, and is bounded on the one side by the Olympus Range and on the other by Mount Hugel.

Having thus briefly sketched the main physical features of the lake and its surroundings, we will be in a better position to consider the geology.

According to the map in Mr. R. M. Johnston's excellent work "The Geology of Tasmania," and I believe this is the most recent, the southern and western shores of Lake St. Clair are represented as sedimentary rocks of upper palæozoic, or possibly mesozoic, age. I shall speak of them as carboniferous, provisionally, all to the west of this is put down as greenstone (diabase). A small patch of basalt is represented as occurring about the S.E. extremity of the lake. The carboniferous rocks are marked as abutting on the older palæozoic, along a line running up the northern side of the Vale of Cuvier.

The most important point at present in the geology of this district is the relation of the greenstone to the carboniferous rocks. The earlier geologists, notably Gould, Strzlecki, and Tenison-Wood, were of opinion that the greenstone was post-carboniferous. However, this has been called in question, and Mr. Johnston, though from what he says there would appear to be two greenstones of distinct ages, thinks that "the massive greenstones occupying the more elevated mountain ranges, as well as the greater part of the dividing ranges within the system, have all been erupted prior to the deposit, even of the lower members of the carboniferous system, and that only certain minor ridges, like that at Spring Hill, represent diabasic greenstones of a later date." . . . "The great inland greenstone plateau of the lake country," according to Mr. Johnston, "probably formed an elevated island mass of considerable extent" (in the carboniferous sea).*

It may be said that Mount Olympus affords the key to the geology of the district. As already remarked, the Olympus Range skirts the western shore of Lake St. Clair, terminating at the lower end of the Vale of Cuvier. One of the best views of the mountain is obtained from about half way, or a little more up the lake. Here the crest of the mountain, rising to 2,300 feet above the water, consists of massive columnar greenstone, the columns rising vertically for several hundred feet, their bases being concealed beneath the ruins of their fallen comrades. Below this greenstone crest appear horizontal beds of sandstone, extending to the shore of the lake below, and forming apparently the base of the mountain, which is covered up to the greenstone with a luxuriant vegetation of beech *(Fagus Cunninghami)*, sassafras, and ferns, etc. The greenstone crest forms a rugged ridge for the northern half of the mountain. Running from N.W. to S.E. it terminates abruptly in a mighty columnar wall, and the ridge of the mountain is now continued at a much lower level, 950 or 1,000 feet, above the lake. It slopes down to its termination at the Cuvier Valley. This ridge we ascended from the lake side, at a distance of about three miles from the boat-house on Cynthia Bay. We found it to consist of sandstone from the base to the summit, the beds being almost, if not quite, horizontal. The sandstone is of medium texture, and rather soft. It forms vertical cliffs along the sides of the mountain at various levels, and in many places is weathered into caves of limited extent. We were unable to follow this ridge to its termination, and so cannot say definitely if the sandstone occurs on the summit all the way. It is probable that it does, for most of the way at any rate. It appears to form the western shore of the lake for its entire distance. So much for the eastern aspect of Olympus.

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* "Geology of Tasmania," by R. M. Johnston, F.L.S., pp. 102, 3.

Passing along Scott's track up the Vale of Cuvier, we crossed over the lower extremity of the Olympus Range. Here we noticed masses of sandstone, and quartz-conglomerate mingled with greenstone, but we could not from mere inspection decide which was *in situ*. As the Cuvier Valley is followed up, it opens out into button-grass plains of a gently undulating and rising character to Lake Petrarch, which, as before mentioned, is about 560 feet above St. Clair. Through these plains protrude bossy masses of greenstone here and there, reminding one of a scene on a Scottish moorland.

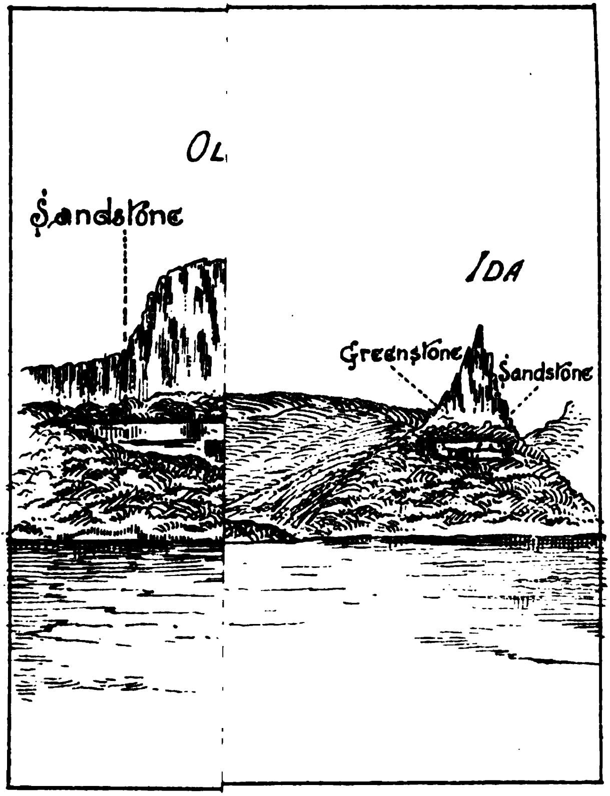
From this side Mount Olympus presents even a grander appearance than on the other, and a more comprehensive view of the mountain is obtained. The greenstone crest is seen rising in giant buttresses, and running almost to the N.W. extremity of the mountain. During our ascent from this side we could not see the character of the underlying rock, owing to the dense vegetation and the mass of *debris* that has fallen from the heights above. On our descent, however, we encountered at 1,500 feet above St. Clair an outcrop of a yellow clayey material, which gave one the impression of a sedimentary deposit that had been baked; but we could not see its actual relation to the greenstone above. About 200 feet below this we found several well-marked outcrops of sandstone, horizontally bedded, and forming the usual vertical cliffs, hollowed out into caves here and there. Springs are very numerous along these sandstone cliffs. There seems to be no reason to doubt that these sedimentary beds extend right along to the N.W. extremity of the mountain, occupying the same position relative to the greenstone on this side that they do on the other. This is indicated by the numerous, and often very large, blocks of sandstone and conglomerate that occur mingled with masses of greenstone towards the upper end of the Cuvier Valley. At one place, just below the southern extremity of Lake Petrarch, these masses of rock form a ridge reaching nearly half-way across the valley. A large boulder of conglomerate can be seen on the S.W. shore of Lake Petrarch, which has evidently fallen from the heights above. The shores of Lake Petrarch are sandy and gravelly, such as would result from the disintegration of sandstone and conglomerate.

The summit of Mount Olympus is much like that of Mount Wellington, a rough, uneven plateau-like surface, formed by the unequal weathering of the greenstone columns, some of which stand up like sentinels among their fellows; many of them are 15 feet or more in diameter. A noticeable feature is the presence of several large fissures, which gape across the mountain in an east and west direction approximately. The largest of these fissures had a great deal of snow lying in it, so that we could not see the depth; 50 or 60 feet would be somewhere near it. These fissures are being filled up by the falling columns. As to their origin I do not care to speak definitely. Perhaps they are due to dislocations, perhaps to the undermining action of water in wearing away the underlying rock.

From Olympus it is seen that the Traveller Range on the opposite side of the lake is really the edge of a plateau stretching away for miles beyond. This plateau is of greenstone, and its roughly undulating surface is studded over with lakes and tarns of all sizes, recalling the Scottish Highlands again. The Traveller Range preserves an even, slightly undulating summit till it is terminated by the deep valley that separates it from Mount Ida. The structure of Mount Ida is a repetition of that of Olympus, a crest of greenstone with horizontally bedded sandstone below. We did not reach the top of Ida, but went about half-way up from the lake side. A stream that flows down between Mount Ida and the ranges to the north we followod up for some distance and found that we were on sandstone all the way. From Lake Laura, lying beneath Mount Ida, and slightly to the N.W., a splendid view of the mountain is obtained, the horizontal beds of sandstone being clearly seen at about two-thirds of the way up the mountain, while the sharp peak of columnar greenstone stands out clearly against the sky. The Eldon Range, to the N.W. of Olympus, according to the geological map, presents the same appearance as Olympus and Ida, viz., a greenstone centre or crest, with a base of sandstone.

The appearances I have described seem to me to point clearly to the greenstone being of later date than the sandstone. Supposing the greenstone to be anterior to the sandstone we should have to believe that the greenstone portions of Mounts Olympus, Ida, Byron, Eldon Range, etc., are much the same to-day as they were in carboniferous times, and we should also have to believe that the sandstone which, according to this theory, was deposited round the greenstone peaks, has weathered in so remarkable a manner as to form regular rings round the greenstone centre. This seems most improbable.

That the greenstone is of later date than the sandstone is supported by further considerations. Suppose the greenstone were of prior date, and a submergence were taking place, on account of the columnar structure of these rocks the amount of *debris* would be very great, and all the shore material, shingle, etc., would be almost entirely composed of greenstone, and there would be comparatively little sand. Now I have not seen a trace of greenstone nor anything like it in any of the sandstone or conglomerate examined. One would expect that so close to the shore, as, for instance, the sandstone of Olympus, must have been deposited, on this theory, the material laid down would be almost entirely a conglomerate of greenstone. So far as we have seen the sandstone is a rather fine or medium-grained silicious one. Where conglomerate occurs the included pebbles consist of material derived from the older rocks, such as quartz, quartzite, jaspar, lydian stone, cornelian, etc. Quartz-porphyry probably also occurs in this conglomerate, as pebbles of this rock are not uncommon on the stretches of gravelly beach here and there along the lake. Further, against such a coast as the greenstone would make, the water would be deep, and the angle of deposition of any sedimentary material would be considerable, dipping away from the shore in all directions. So far as we have seen there is no trace of this in the sandstone ; on the contrary, one of its most striking features is its horizontality, even close up to the greenstone. Again, it seems to me rather improbable that a rock material having the structure of this greenstone could have survived to such an extent since pre-carboniferous times. One of the most noticeable features about the mountains in this district is the enormous amount of greenstone *debris* that covers their flanks, showing how rapidly the work of denudation is proceeding. And is it not likely that if the greenstone were anterior to the sandstone, that the lines of junction between the two formations would be just where we might expect to get the main valleys, as it would be here that erosion and denudation would act most rapidly, and it would be rare to find the sandstone abutting against the greenstone, as we now find it?



From what I have said about the structure of Mount Olympus, it might be expected that sandstone should form the bed of the Cuvier Valley. But, as before remarked, only bosses of greenstone appear through the button-grass, except at the upper end, where masses of sandstone and conglomerate above the Nive Plains. From here right on to the Dee the map represents the rocks as entirely greenstone, but the road crosses several outcrops of sandstone, one being about a mile across. There are no good sections exposed along the track, so that the relations could not be clearly seen.

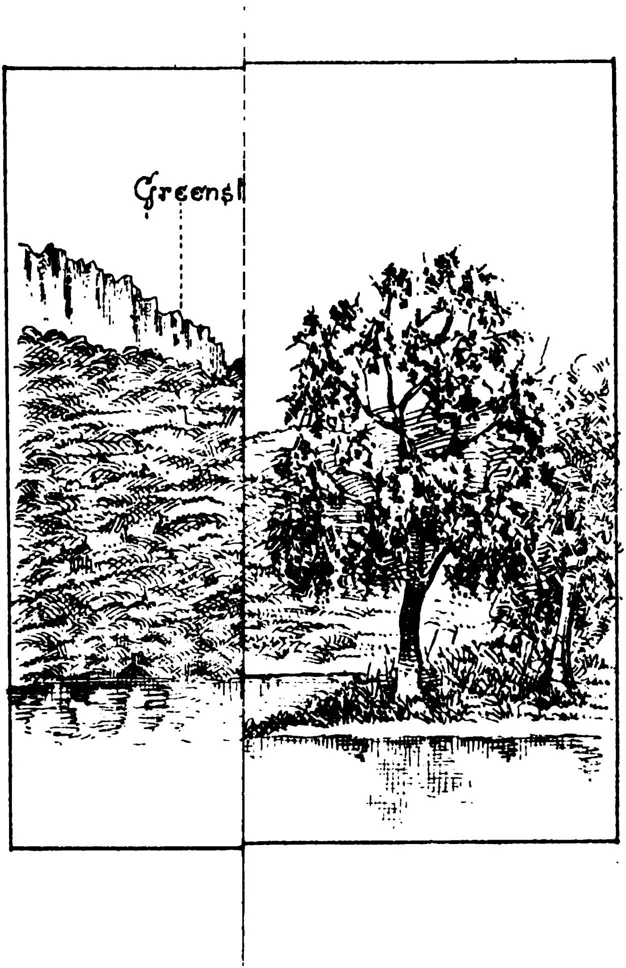
I think I have now shown good reasons for believing that the greenstone of the lake country is of subsequent date to the carboniferous (?) sandstones. Moreover it seems probable that these sandstones had been elevated and carved into all the varied features of a land surface when the floods of lava, now represented by the greenstone, overwhelmed the country. Since then enormous denudation has taken place, accompanied probably by considerable dislocations and displacements, and the greenstone crests of Olympus, Byron, Ida, and all the other mountains of similar structure (in this district at least) are merely outliers, the remnants of a once vast and continuous sheet of lava. The evidence of this enormous denudation is about the most striking feature that catches the geologist's eye when he ascends Mount Olympus for instance, giving him some idea of the magnitude of those forces which, though apparently trivial in themselves, are yet capable of producing such grand and imposing effects.

The origin of the lakes of the great central plateau is a question which affords ample scope to any geologist who will undertake their investigation.

Lake St. Clair was, I believe, first supposed to be a crater lake, but of this there is no evidence. Mr. Gould explained it on the theory of a flow of basalt damming up the lower end of the valley in which the lake lies. However, I am much inclined to doubt the existence of this basalt. From a mere casual inspection, the rocks about this end of the lake seemed to us to be the ordinary greenstone. We had intended to make a special expedition from our camp to settle this point, but were prevented by bad weather at the last.

The eastern third of the southern shore of the lake is bounded by a bank of sand which is covered sparsely with timber and in places is honey-combed by wombat-holes. The lake is very shallow in this locality, and knobs of greenstone can be seen projecting above the water at a considerable distance out from the shore. The upper end of the lake appears to be shallow as well as the lower. The ridge of sand just mentioned separates the lake from an extensive button-grass flat, which extends eastwards till it merges into the swamps that mark the entrance to the Derwent. It seems pretty certain that the waters of the lake once covered this flat. As Tasmania is undergoing a movement of upheaval the rivers must, geologically speaking, be rapidly lowering their channels. The course of the Derwent affords ample evidence of this. Thus the level of the Lake St. Clair waters must be gradually being reduced. At one place under

Mount Ida we noticed an old beach of conglomerate some feet above the surface of the lake. The addition of several feet of water would cause a considerable extension of the lake



but on the beach about the boat-house pieces of silicified

Nature, Vol. 47, No. 1,219.

wood are not uncommon. These may have come from the sandstone. Before concluding I should say that those who desire a fuller account of the principal physical features of the Lake St. Clair highlands should read a paper by Colonel Legge published in the proceedings of this Society. * Colonel Legge gives a clear and accurate description of this region, and we found his paper of much assistance.

In conclusion I can only say that I feel that the present sketch is incomplete, indeed necessarily so, but still I hope that some light, however little, has been shed on the main geological features of the Lake St. Clair district.

In the accompanying map that portion lying to the N. and N.W. of Mount Byron I have filled in only from observations from the top of Mount Olympus, Mount Manfred and the Ducane range are evidently greenstone, as far as their crests are concerned at least, but Coal Hill and several other minor elevations in its vicinity present an even, flat-topped, and terraced structure that strongly suggests horizontal sandstones.

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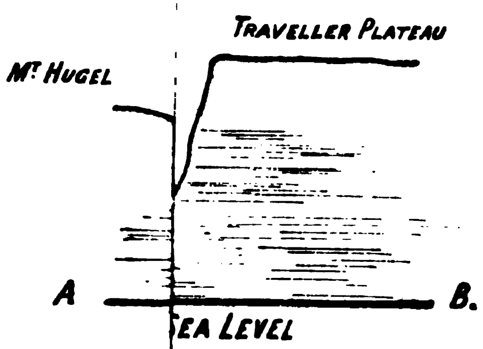
* Proc. Roy. Soc. Tas., 1887.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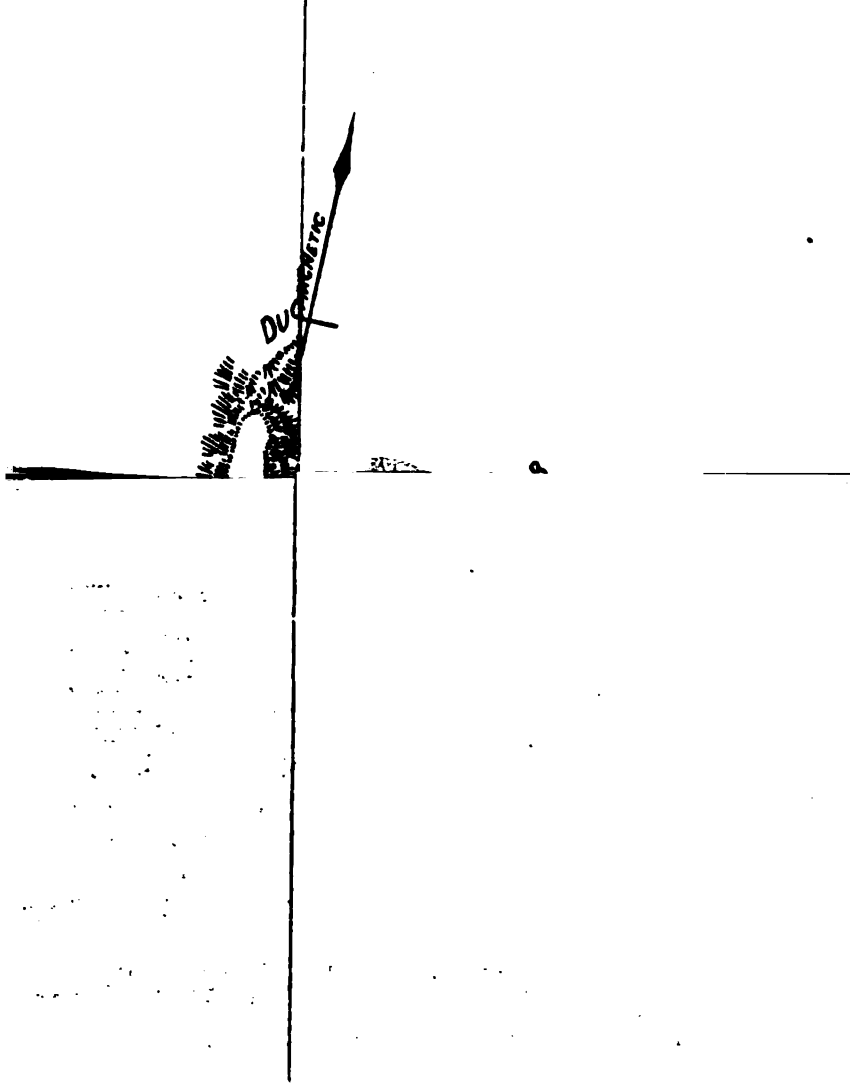
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GLACIAL ACTION IN TASMANIA.

By A. Montgomery M.A.,

Government Geologist of Tasmania.

Through the courtesy of the secretary I have been allowed to read Mr. Moore's paper on "The discovery of glaciation in Tasmania" read at the April meeting of the Royal Society, at which I was unfortunately unable to be present, and have thus been enabled to prepare a few notes upon it. Having myself come upon evidences of ice action in February last in the neighbourhood of Mount Pelion, and being at that time ignorant of Mr. Moore's discovery four months earlier, I had intended in any case to submit to the Society a few observations on the subject of glaciation, and in continuing the discussion on this important and interesting subject I shall make a few remarks upon Mr. Moore's paper, and then pass on to what I saw myself and to a few observations on more general aspects of the matter.

It is by no means a new discovery, as Mr. Moore appears to think, that there have been glaciers among our western highlands, for Mr. R. M. Johnston, and, if I am not mistaken, the late Mr. Sprent also, noticed the existence of large erratic blocks in the valley of the Macintosh River, and inferred from these that they must have been brought down by ice, and Messrs. Dunn and Moore's and my own later finding of striated boulders, smoothed surfaces, *roches-moutonnées*, and moraine drifts, only confirms the correctness of the views of these earlier observers. Mr. Moore is therefore in error in ascribing to Mr. Dunn the honour of being the discoverer of evidences of glacial action in Tasmania, though perhaps he was the first to bring forward indisputable proofs.

The country described by Mr. Moore round Mounts Sedgwick and Tyndall and Lake Dora is very similar to that round Mount Pelion. The conglomerates which he speaks of as Devonian are of much interest, and the results of further examination of them and fossil evidence as to their age will no doubt add an important chapter to our knowledge of the geology of the colony. In my journey from Barn Bluff to Zeehan I noticed conglomerates of, I take it, three distinct ages: 1. A coarse conglomerate composed mainly of thoroughly waterworn pebbles of micaceous schists and quartzite lying in horizontal layers unconformably on the upturned edges of ancient schists and quartzites, and constituting the lowest beds of the permo-carboniferous coal measures; (2) a very similar coarse pebble conglomerate lying on the edges of older strata towards the south end of Mount Murchison. This one, I think, is older than the coal measures, and may be the Devonian conglomerate of Mr. Moore, but fossil evidence is not yet available to decide its age. And 3. A somewhat similar conglomerate conformably bedded with the quartzites and schists and intercalated in layers in them. This differs from the two former ones in being much more jointed, the joint planes passing fairly through the component pebbles, and in being also so thoroughly cemented together that when the rock is broken the pebbles do not break out from their setting but right across their substance. The conglomerates of Mount Owen, Mount Zeehan, and parts of Mount Reid are of this third class, conformably bedded with slate and sandstone. I am not yet prepared to say that the quartzites and schists of the Upper Forth, and westward thence to Mount Murchison, are of the same age as the sandstones and slates of Mount Zeehan, though the included conglomerates among the quartzites are very similar to those among the sandstones of Mount Owen, but I have not seen any signs of uncomformability up to the present, and the difference of lithological character may be due simply to the first named being nearer the axis of the mountain-making movement or crumpling. Nevertheless it seems rather more probable that the quartzites are older altogether than the Zeehan fossiliferous strata. The general strike of both formations, supposing them to be different, being the same, about N.N.W., and both lying inclined at high angles, it is likely to be a matter of difficulty to establish the fact of difference of age by stratigraphical evidence alone, and the paucity of fossils debars us from getting good palæontological proof.

Mr. Moore mentions that Mount Sedgwick is capped with diabase greenstone, as is also Mount Dundas; to these we may add Barn Bluff, Mount Pelion, Mount Ossa, the Ducane Range, the Eldon Range, East Mount Pelion, and the Oakley Range, as all showing the same feature. It seems manifest to me that the great greenstone plateau in the centre of the island, the northern edge of which forms the Western Tiers, once extended westward so as to include all these peaks, and it is probable that ice action had a great deal to do with carving out the deep valleys that now separate them. I do not mean to say that ice has been the only considerable agent in cutting out the valleys, for these highlands do not appear to have ever been under water since the eruption of the greenstones in mesozoic times, and great subaerial erosion must have taken place before the coming of the ice sheets, which, as we shall see later on, probably did not exist till a comparatively recent time, later tertiary or even pleistocene.

The shape of many of the valleys, and the contour of the hillsides suggest, however, that the present configuration of the surface is largely due to glacial erosion, and it is probable that during the ice period the valleys, already partly worn out by running waters, were immensely deepened and enlarged by the accumulation in them of glaciers.

At the head of the Forth Valley it is very evident that the diabase greenstone is a horizontal sheet overlying the quartzites and permo-carboniferous strata, for on every hillside forming the amphitheatre at the head of the valley the same features present themselves; first, highly inclined quartzites in all the deep gullies at the base of the mountains, the lying on these horizontal coal measures, sandstones, and mudstones; then at about the same level on every peak we find the columnar greenstone resting on the coal measures. On East Mount Pelion and Barn Bluff the residual mass of greenstone left on the top of the sedimentary strata is very small, and the undisturbed coal measures are visible all round the peaks. Mr. Moore mentions the occurrence of coal-measure fossils in the moraine at Mount Sedgwick, and it will no doubt prove that the sedimentary strata there too underlie the greenstone capping. I cannot think it at all probable that Mr. Moore is correct in referring the conglomerate containing fossils to the action of floating ice; it seems much more likely that it is a moraine drift derived from the lower beds of the carboniferous formation, which, further north near Barn Bluff and Cradle Mountain, consist mainly of conglomerates. These would supply the stones of granite, slate, porphyry, etc., which Mr. Moore has noticed, and also the fossils, and I have little doubt that when he comes to examine the country more thoroughly he will find these beds *in situ* under the greenstone capping. It is hardly conceivable that if the conglomerate was deposited by floating ice in permo-carboniferous times, which is what Mr. Moore's words seem to imply, that it should happen that the only proof of such ice action should be found in a region where there has been evidently severe glaciation at a much later date. Before accepting such a theory we should first have to eliminate all possibility of the conglomerate having been formed at the later period. Round Mount Pelion there is direct proof that the glaciation took place long after the permo-carboniferous period and after the diabase greenstone had covered the strata of the latter, and Mr. Moore's observations of striated greenstone blocks on Mount Sedgwick show the same thing.

The first place in which I came upon plain proof of ice action was near East Mount Pelion, between a branch of the River Forth flowing from that mountain and from Lake Eyre, and another small feeder running in a deeper gully at the foot of the Oakleigh Range. Between these branches of the Forth there is a ridge rising to a height of perhaps 150 feet above the level of Lake Eyre, and highest at the north end. The whole of this ridge is a succession of *roches-moutonnées* of the most typical shapes, with long rounded stopes towards the south, and short steep ones towards the north, the direction of motion of the glacier having been northward down the valley of the Forth. Between the hummocks are numerous small ponds and tarns, with their bottoms much deeper than their outlets. Some of these are grown over with swampy vegetation, and form minute peat mosses, but many still show their rocky beds. Towards the south end of the ridge the country rock is mostly schist, and though the general shapes of the *roches-moutonnées* are well marked and characteristic, striations on the rock surface have been obliterated by the weathering of the exposed surfaces, but further north, where the rock is a very dense and hard quartzite, the planed surfaces are wonderfully clear, and it is difficult to find a place where a stone showing the smoothed surface can be knocked out of them, so little disintegration of the rock has taken place. Owing to the extreme hardness of the quartzite the surfaces are not as a rule striated, but polished smooth, often almost as smooth as glass. All over the ridge numerous erratic blocks of greenstone are scattered, and as this part of the ground is separated by valleys from the slopes of the surrounding hills running up to the greenstone cappings, and there is no possibility of their having been carried uphill by running waters, it is plain that these have been transported to their present situatians by ice. It serves to give some idea of the antiquity of the ice action that these greenstone erratics are very little decomposed, being as sound and unweathered as the stones lying on the tops of Mount Wellington and Ben Lomond. When we consider that the greenstone is a felspathic rock, and weathers rather easily (the stones of it in the neogene tertiary drifts round Launceston, for example, being generally pretty thoroughly decomposed), we see that the date of the glaciation must not be referred to the very distant past, but is more likely to be pleistocene. The splendid state of preservation of the ice-worn surfaces also favours the view that they are not very ancient, for even a quartzite must suffer considerable disintegration if exposed to rain and frost, such as every winter brings in this high-lying part of [the country, at an altitude of between 2,000 and 3,000 feet. The evidences of glacial action seen by Mr. Moore also appear from the description to indicate a comparatively recent date.

The high narrow plateau lying between Mount Pelion and Barn Bluff shows in its every contour the former presence of glaciers; it is a succession of low rolling hummocks of rounded outlines, and full of small lakes and tarns. From the top of Barn Bluff I counted over one hundred little lakes in sight at one time in this plateau, and there are probably several hundreds in all. Some of these little lakes are very pretty, Lake Isles in particular; but indeed the whole of the scenery of this part of the country is most beautiful.

On the slopes of Barn Bluff there are two or more lines of moraine ridges, separating flat valleys, which have been the beds of adjacent glaciers; these are mainly composed of immense loose blocks of greenstone from the cap of the peak. The discovery of loose angular blocks of cannel coal on the south-east spur from Barn Bluff has led to some of the ground being laid open by mining operations, and it is soon seen that the fragments are portion of a ground moraine. The superficial soil, to a depth of over 20 feet in parts, is composed entirely of angular fragments of the adjacent rocks of all sizes, jumbled together in the wildest confusion. In one of the pits a large sheet of cannel coal, evidently lifted as a whole from the main seam, was come upon, and proved to extend over a space some 16 feet square, or more, but when cut through it was found to be resting on loose angular fragmentary material, in which, among other things, were angular blocks of the coal itself, one piece standing on edge immediately under the large sheet. No landslip or river could carry such a sheet of coal without breaking it, but ice could easily lift it from its bed, and transport it a very considerable distance uninjured. It may be remarked that the lumps of cannel lying about the surface of the ground are nearly of as good quality as those dug up from some feet deep, so that exposure to the weather has not had much effect on the mineral. This coal, which, by the way is associated with fragments of shale carrying prints of a *Glossopteris* and a *Noeggerathiopsis*, and therefore belongs to the lower or Mersey coal measures, is a very bituminous substance, and would doubtless resist atmospheric alteration for a very long time, but I hardly think it possible for it to have been exposed or lying near the surface from, say, the miocene period till now without very perceptible oxidation; its good state of preservation, therefore, strengthens my belief that the glaciation is of pleistocene date. Another argument in favour of a comparatively modern date being ascribed to it is found in the small amount of destruction of the ground moraine by subaerial erosion, the ground having all the appearance of not having long been denuded of its ice covering, and not being cut into fresh shapes by the modern watercourses, as we should expect if it had long been exposed to their action, especially in a district where the rainfall is so heavy as round Cradle Mountain.

Going from Barn Bluff towards Granite Tor the rolling hummocks and rounded ridges continue to be met with on the high lands, and descending suddenly and abruptly from these are huge deep ravines and valleys. It is noticeable that in many of these the streams in the bottom of the ravines are quite insignificant in size, and not at all likely to have been sufficient to eat out such huge valleys. Even where they are fairly large rivers, as in the case of the Fury, Forth, Bluff, and Sophia rivers, it may be noticed that the sides of the gorges have on the whole broad flat slopes, and present a generally even outline; they are scarred with deep little ravines, it is true, in which there are watercourses, but these from a little distance are almost invisible. This points to the likelihood of the main deep gorges having been the beds of glaciers, the erosion by running water since the retirement of the ice having been sufficient to greatly alter the contours shaped by the latter. All across from Barn Bluff to Mount Reid the solid rock seems to be immediately under the very shallow surface soil, both on the ridges and in the valleys, as if there had not been time for the formation of accumulations of superficial *debris* to any considerable extent since the times when the ice planed away all the loose stuff covering the solid rock. Throughout this district the contours of the hills are on the whole wide, broad, and flat slopes, not the sharp, jagged, broken outlines which we should expect to find in schist and quartzite country carved only by running water.

The lakes at the head of the west branch of the Murchison River, and on the divide between it and the Henty, Lakes Spicer, Dora, Beatrice, Rolleston, Julia, Selina, etc., also probably indicate the former presence of glaciers, and I think we must come to the conclusion that the whole of the deep gorges among these western mountains, now occupied by the headwaters of the Pieman, Henty, and King Rivers, have been at no very distant period of time occupied by rivers of ice. The erratic blocks noted by Mr. R. M. Johnston in the Mackintosh Valley quite bear out this conclusion. It is very likely that the ice had retired from the low-lying valleys long before it finally disappeared from the tops of the ranges, just as in the New Zealand Alps we find indications that the present glaciers once extended much lower down, and therefore the smoothed surfaces at Mount Pelion and Lake Dora may be of much later date than the erosion of the main valleys, but nevertheless it seems probable that the whole of the present shape of the country along the West Coast Range is due to ice action of comparatively recent date.

If we allow that the deep valleys at the head of the Pieman were once occupied by glaciers, we must admit that the ice came down to within 500 or 600 feet of the present sea level, for these gorges are very deep, or perhaps we should rather say to points which are now that distance above the sea, for of course it is quite possible that there has been elevation or subsidence of the land as a whole since the ice age. Later on, however, I shall point out that there has been no subsidence of the country worth mentioning during the period when these masses of ice existed, but rather elevation, the land being probably higher now than then. Now if the ice lay so low in these valleys, what about other parts of the colony? The glaciers would not be likely to be confined to one district, but would be on the other high lands as well. Ben Lomond, Mount Wellington, and the Great Central Plateau probably also had their share of ice and perpetual snow. The great lakes on the Central Plateau are almost *prima facie* evidence of glaciation, ice being one of the most common causes of the formation of lakes. On Ben Lomond also there is a lake for which it is hard to account, except as having been formed by ice; and the peculiar flat shelf on the south side of the Butts at the foot of the talus slope, a plain some four or five miles long and two miles wide, on which most of the Ben Lomond mines are situated, is also difficult of explanation. It may perhaps have been the seat of a glacier, from which branches ran down Story's Creek, the Castle Carey Creek, and Gipp's Creek. On the slopes of Mount Nicholas the coal-bearing sandstones are overlaid by a heavy superficial covering of loose greenstone drift derived from the capping or central ridge, whichever it may prove to be, of the range. Going over this lately it seemed to me that simple landslips and rolling down of loose stones from the higher ground were not sufficient to account for the immense quantities of loose superficial rock, and one is strongly tempted to regard this as moraine stuff. More evidence is required before accepting this view, but it seems to me to have a good deal of probability. We shall probably yet have to ascribe the shape of a great many natural features of the country to glacial action, but while this is suggested as a potent cause I must admit that evidence is wanting to prove widespread glaciation in the eastern parts of the colony, and I mention the matter rather because it seems an almost necessary consequence of admitting the prevalence of ice in the western highlands that it should also have existed in the east, than on account of any direct proof.

At the head of the Ring River on the western slope of Mount Reid there has been discovered a "deep lead" which presents some features suggestive of ice action. The upper part of the filling of the old river valley forming the lead for upwards of 100 feet, and perhaps more, consists of very thin layers of fine sandy clay, perfectly horizontally bedded, the sediments having been plainly laid down in very still water. These clays are exactly like the glacial clays now being deposited in South Canterbury, New Zealand, in lakes fed with turbid water issuing from beneath glaciers. While the clays have been laid down in still water, it is equally clear that the coarse gravel and boulders in the bottom of the lead have been deposited in the bed of a running stream, and it is therefore evident that the valley of a once turbulent watercourse has been somehow converted into a deep and still lake. The stream appears to have run to the northward, in quite a different direction to the present Ring River, and the valley of the latter must have been eroded since the older river system was covered up and obliterated, for it cuts through the above clayey layers to some depth. Seeing that there are grounds for considering the valley of the Mackintosh to have been scoured out by glacial action, it seems reasonable to suppose that the old Ring River became dammed by the advancing ice and its valley converted into a lake, which became rapidly filled with glacial sediments. The ice-sheets still advancing probably performed much of the work of erosion of the present Ring River Valley. Lower down this, it may be mentioned, we have further proof in the finding of gravel terraces 200 feet above the present stream, that an older river system has been almost entirely obliterated. The clays of the Deep Lead, so far as yet known, are very free from fossils which would give evidence as to its age, but as work proceeds it is probable that some leaves will be found which will help us to fix their date.

It has always been regarded by mining men as an uncommon feature in connection with the Mount Bischoff tin deposits that there was little or no trace of tin ore in the rivers and creeks heading from the rich gravels on the Mount, it being usual under such circumstances for the ore to be found for miles down the streams draining from the lodes or older gravel deposits. As the plateau round Waratah is high enough to have been well above the probable snow-line at the time of the glaciation of the country further inland, it seems possible that the deep gorges of the North Valley and Arthur Rivers may have been glacier beds, a supposition which their depth and shape give some colour to. If these valleys were cut out by ice the stanniferous gravels would have no opportunity of being sluiced over and over again in the streams, so as to distribute the ore along their courses for long distances, but would be swept clean away with other rock *debris*. Should evidence be by and bye obtained to bear out this explanation, it would have further interest as giving a clue to the time of glaciation, for the Waratah plateau consists of basalt of tertiary age, overlying tertiary leaf beds, and the Waratah valley up to the railway station has been cut through these basalts. The basaltic outbursts appear throughout this colony to have been between the palæogene and neogene periods, or probably pleiocene; and this would make the glacial action either pleiocene or post-pleiocene. Not having direct proof of glaciation at Mount Bischoff, this argument is not convincing, but taken in conjunction with the fact next to be mentioned, it has weight. On Gads Hill, and at various points along the top of the Oakley Range, the same tertiary basalt is found as a superficial covering, and an escarpment of it forms the western edge of the plateaux on the top of the Oakley Range and overlooking the River Forth. The valley of the Forth has plainly been scooped out since the basalt was poured out, and as we have seen, at the head of this valley, the proofs of the presence of glaciers are very well marked. Consequently the pleiocene or later age of the glaciation must be regarded as demonstrated. It may here be remarked that, according to Dr. von Lenderfeld, the evidences of glacial action in the Australian Alps point to its having taken place at quite a recent date, and with this corroboration I think that it is most likely that our glaciers existed as late as the pleistocene period. As above stated, the excellent preservation of the rock surfaces, the slight decomposition of the greenstone erratics, and the small amount of erosion of the ground moraine at Barn Bluff, all go to show a very recent date, geologically speaking.

The importance of being able to limit the probable period of existence of the glaciers to neogene and recent periods becomes apparent when we come to consider the questions of the cause and extent of the glaciation of the country, and as to whether our cold period had any connection with the glacial period of the Northern Hemisphere. First let us glance at the causes of glaciation: It might be due to greater elevation of the land, to geographical changes resulting in a redistribution of sea and land, diversion of ocean currents, and so on, or it might be due to astronomical, causes as so lucidly explained by Sir Robert Ball in his recently-published little book on "The Cause of an Ice Age." Having limited the period of existence of the glaciers to the time between the outpouring of the basalts and the present day, we can examine the evidence of our later tertiary deposits to find if there is any indication of the country having subsided from a higher elevation to a lower one. We find that all round the island, in the Launceston tertiary basin, in that of the Derwent, at Macquarie Harbour, and at Oyster Bay, there are palaeogene lacustrine deposits laid down in hollows, the bottoms of which are often much below present sea level, and which are in the Launceston Basin as much as 1,000 feet in thickness. They have doubtless been formed during a period of continuous subsidence extending throughout the palæogene period. After the basaltic eruptions which closed the latter, the land appears to have risen again gradually, and the palæogene sediments have been deeply cut into. The terraced gravels of the Ringarooma Valley and North-eastern Tasmania generally, show that the elevation has been practically continuous, though on the islands in Bass Straits there are proofs of minor oscillations of level, hence we must conclude that the general elevation of the country is now higher than it has been since the early part of the palæogene period. It has not risen quite so high as previous to the great subsidence, for we find deep leads at Beaconsfield and George's Bay running considerably below sea level (270 feet at Beaconsfield), and the old channel of the Ringarooma River at Derby is more than 90 feet lower than the present one. No elevation of the country sufficient to cause its glaciation has therefore occurred since the beginning, probably, of the miocene period.

The second great cause of accumulation of ice is found in geographical changes leading to a redistribution of sea and land, alteration of ocean currents, and change in the direction of prevalent winds. The most important change which would be likely to affect Tasmania in this respect would be the opening of Bass Strait, and the severance of this island from the Continent. The biological proof is conclusive that there was practically unbroken land connection between us and the mainland up to early in the pleiocene period, and if the glaciation had taken place before the severance, it would be easy to suppose that the opening of the strait had led to an amelioration of climate, but as it appears to have been later than this, it is hard to conceive any reason for formation of glaciers which would not exist now as well. In the neogene and recent period, too, we have no evidence of changes in the Australian Continent which could have any effect upon our climate, and consequently we have to abandon this explanation also.

It is therefore probable that the refrigeration of the climate of Tasmania, which led to the gathering of glaciers on its high mountains, was due to the causes insisted upon by Dr. Croll and Sir Robert Ball. It is most likely true that these causes are not, of themselves, sufficient to account for a period of extreme glaciation such as was experienced in the Northern Hemisphere in the glacial period without the concurrence of geographical changes favourable to its production, but nevertheless the astronomical and physical argument is so strong that we must concede that it would account for a very considerable refrigeration.

In discussing the subject of the climate of this colony during the neogene period, Mr. R. M. Johnston considers that there is no evidence of glacial action in the lower lying lands, and regards the glaciers as having been of small extent. While inclined to believe that the ice covering has been more extensive than he is disposed to allow, in the main I agree with his view, and do not think that the whole country could have been ice bound. Many of our indigenous animals existed in the colony before the probable date of the glaciation, and if the latter had been extreme would have been killed out altogether, in which case, if I am right in referring the cold period to a time subsequent to the severance of Tasmania from the Australian Continent, there would have been no chance of a fresh stock having been obtained from the mainland after the climate again became milder.

Outside of this colony evidences of glacial action have been found in the Australian Alps and on the beach near Adelaide. The latter occurrence, first described by Professor Tate, has been questioned, but is confirmed by Mr. R. L. Jack, who visited the place in 1891. The glaciation marks in the Australian Alps seem to be very similar to those in our highlands, but the Adelaide occurrence is not so easy of explanation, apparently indicating a large glacier at sea level at a period later than miocene. Mr. Jack ("Geology of Queensland," p. 619), in referring to this, also quotes from the "Challenger" reports to show that Kerguelen Land, too, has been at no ancient date completely covered by heavy ice, and points out that if the Antarctic ice-cap were extended to cover Kerguelen Land, there would be no improbability of its also reaching the shores of Australia.

The whole subject is most interesting, and has numerous aspects on which more light is required, and fresh proofs of the extent and date of the glacial action all over the Southern Hemisphere will be eagerly looked forward to.

FURTHER CONTRIBUTIONS TO THE FOSSIL FLORA OF TASMANIA

Part I.

[By R. M. Johnston, F.L.S.]

The following descriptions and observations are principally based upon collections made recently in a tour of examination of the rocks in the southernmost part of the island, and particularly that portion lying between Southport and South Cape. Some of the plants referred to, however, have been obtained from the coal measures near Spring Bay, and others from the tertiary leaf beds underlying the basaltic cap at the Forest, near Glenora railway station.

Pecopteris Lunensis, *nov. sp.* Pl. I., figs. 5, 6, 7.

Frond or Pinna? 3—3½ in length; 4—6 lines broad, symmetrical, the larger ones linear-lanceolate, or lingulate; the smaller ones sometimes narrowly spathulate; commonly tapering gradually upwards to pointed or bluntish apex, and constricted rather abruptly towards the short stem; texture somewhat membranaceous; margins simple, never incised or lobed, although occasionally wavy or slightly undulating; mid-rib firm, evanescing at apex; veins free, fine, distinct, arising from midrib at an acute angle, and then curving outwards to margin, each primary nerve bifurcate, or branching dichotomously. One remarkable example of these fronds is divided, or dichotomised within an inch of the apex, each division being marked with the same simple characters exhibited in the lower undivided portion.

Obs.—This interesting fern occurs in the greatest abundan in the shales associated with the four-feet coal seam just opened out near Ida Bay, Southport. These shales are replete only with this one form. Two other associates occur, sparingly, viz., *Zeugophyllites elongatus* (Morris) and *Vertebraria Australis*. In the black shales, further east at Southport, I have also discovered the fronds of *P. Lunensis*, but here they are found sparingly associated with *Vertebraria Australis*. The latter occurs in these Southport beds in the most wonderful profusion, as in the shales of Port Cygnet a short distance to the north-east. It is probable that the simple fronds of *P. Lunensis* belong to a tufted form, as, in the thousands of examples examined by me, I have not been able to trace attachment as in bipirmate, dichotomous, or compound species. The only kind of attachment which might break up so completely, by pressure, would be that exhibited in the zigzag dichotomy of such forms as the existing *Gleichenia Cunninghami*, or *G. dicarpa*.

The nearest ally with which I am acquainted appears to be *Pecopteris caudata* (mihi) occurs in the York Plains shales. The latter species, however, appears to be of a more coriaceous texture, and the lower portion of the pinna or frond is invariably incised or lobed.

Locality and Horizon.—Ida Bay and Southport.

The beds exposed along the shore at the Red Bluff, near Kennedy's Hotel, afford the best evidence of the nature and sequence of the various members of the coal measures, containing *P. Lunensis* (mihi) and *Vertebraria Australis*. The north-eastern horn of the Southport Bay is composed of greenstone, against which the Permo-Carboniferous mudstones form a broken fringe along the shore towards the police station westward. The "Stack of Bricks" islet, at the Heads, is also a fragment or survival of the mudstone series, which at one time probably occupied the whole of the eastern part of the present bay. The whole of these mudstones dip very slightly south and west. The junction with the succeeding coal measures below Kennedy's Hotel is concealed by a low lying tract of sand. Below Kennedy's Hotel the lower beds of the coal measures first make their appearance in low-lying flat reefs or terraces, all of which have a uniform dip of from 10 to 15 degress to the south-west in the direction of Ida Bay, and disappear in a distance of about 300 yards, at the same angle under the reddish sandstone of the Red Bluff. The lower division is composed of a series of thin laminated beds of sandstone, alternating with similar thin laminated blackish arenaceous shales. The thickness of those in view probably does not in all exceed 50 feet. Although some of the shales are highly carbonaceous, there is no appearance of coal seams. The blackish shales, however, are rich in plant impressions, mainly the remains of *Vertebraria Australis* (M'Coy). *P. Lunensis*, its associate, only occurs sparingly at this place. The irregularly bedded reddish sandstones succeeding the shales rise into a bold bluff towards the east, upon which is built the Roman Catholic Church.

The lower part of these sandstones, however, are laminated and flaggy. On the shore some parts of the exposed surface exhibit fine examples of ripple marking. The wavy ripples generally agree in direction, being generally at right angles to line of dip. The total thickness of the formation at Southport probably does not exceed 300 feet.

Ida Bay.—The members of this division again appear a few miles further east in the vicinity of Ida Bay. My information from this particular locality has in part been supplied by Mr. Schachner, who is engaged in working one of the coal seams (about 4 feet thick) developed in the formation at this place. I have not yet obtained full particulars of the sections opened out, but hope to do so shortly.

The shales associated with the coal here are almost wholly composed of the remains of *P. Lunensis*, although at Southport it only occurs rarely. It is also of interest to find that the associated form here is *Zeugophyllites elongatus*, (Morris). *Vertebraria Australis* (M‘Coy) the characteristic form at Southport has evidently disappeared entirely. It may be remembered that the earliest known habitat of *Vertebraria Australis* (M‘Coy) in Tasmania was discovered by the writer some years ago associated with an anthracite coal seam at Mount Cygnet. The beds at this place, like those further south at Adventure Bay, are intimately associated with the upper members of the marine mudstones of Permo-Carboniferous age, upon which they lie conformably in unbroken stratigraphic succession. Both at Adventure Bay and Mount Cygnet the characteristic plants are of a *Permo-Carboniferous* character, consisting almost entirely of remains of *Vertebraria Australis* (M‘Coy) and *Gangamopteris spathulata* (M‘Coy). Dr. Feistmantel, at the time he published his last memoir, only knew of the existence of *Vertebraria Australis* (M‘Coy) in connection with the "Newcastle beds (upper coal measures) of New South Wales at various localities," which he refers to *Permian* age. It is significant to note the gradual appearance and disappearance of *Vertebraria Australis* (M‘Coy), associated at their origin by such a purely restricted Permo-Carboniferous form as *Gangamopteris spathulata* (M‘Coy) as at Adventure Bay and Mount Cygnet, and linked as it disappears with the beginnings of mesozoic plants such as Zeugophyllites at Ida Bay, and with the form *Pecopteris Lunensis* (mihi), which latter serves to link together the *Vertebraria* shales of Southport with the prevailing *P. Lunensis* and *Zeugophyllites elongatus* shales of Ida Bay. It would seem probable, therefore, that the Southport and Ida Bay formations supply an important link in the chain of plant life, connecting the close of the *Permo-Carboniferous* period with the beginnings of the mesozoic period; and the following may be taken as the sequence of the typical formations, taking in order the formations in Tasmania, beginning with the lower marine beds of Permo-Carboniferous age, thus:—

	Formations.	Characteristic Form.
PERMO-CARBONIFEROUS.	1. Lower Marine Beds.	
	2. Tasmanite Beds.	*Tasmanites punctatus.*
	3. Coal Measures: Mersey, Henty, Tippagory, etc.	*Glossopteris, Gangamopteris, Noeggarithiopsis.*
	4. Upper Marine Beds.	
	5. Adventure Bay Coal Measures.	*Gangamopteris spathulata* & *Vertebraria Australis.*
	6. Mount Cygnet Coal Measures.	
	7. Southport Beds.	*Vertebraria Australis* and *Pecopteris Lunensis.*
MESEZOIC.	8. Lower Sandstones (Lower Mesozoic).	Ganoid Fishes. *Vertebraria.*
	9. Ida Bay Coal Measures.	*Pecopteris Lunensis* and *Zeugophyllites elongatus.*
	10. Upper Coal Measures: Jerusalem, Fingal, Spring Hill York Plains, Hamilton, Richmond New Town, Sandfly, Recherche South Cape, Longford, etc.	 *Pecopteris.* *Alethopteris, Thinnfeldia.* *Sagenopteris, Neuropteris.* *Zeugophyllites, Baiera, etc.*

Recherche and South Cape Coal Measures.—The shales and sandstones occupying the low lying country east of South Cape, and south of Southport, have been so graphically described nearly 40 years ago by Dr. Milligan that little more can be added save as to organic contents. *

It is evident that these beds, containing several coal seams, attain a maximum thickness of about 400 feet in the coast line between South and South-East Cape. These beds evidently succeed the Ida Bay coal measures, and belong to the upper mesozoic group. Thus we have in their shales no longer any representations of *Vertebraria Australis* (M'Coy), or *Pecopteris Lunensis* (mihi), but instead we have abundant remains of upper mesozoic forms, viz.:—

Alethopteris Australis	M'Coy
Thinnfeldia obtusifolia	mihi
Sphenopteris lobifolia	Morris
Baiera tenuifolia	mihi
Zeugophyllites elongatus	Morris
Phyllotheca Australis	M'Coy

and abundant remains of the trunks of silicified conifers.

Localities where beds are best exemplified:—Pedro-Bancho Hill, Black Swan Lagoon, Pigsties, Catamaran Creek, Cockle Creek, Coast between South and South-East Cape.

The whole of the members are everywhere disturbed or overlaid by intrusive greenstones, as in the Jerusalem and other basins.

PECOPTERIS ODONTOPTEROIDES (MORRIS).

Pl. vi., fig. 2, 3, 4.

As there is still much doubt as regards the character and identification of the original forms described under the above name by Professor Morris from specimens obtained from the mesozoic rocks of Tasmania, and probably from sandstones of the Jerusalem Basin near Spring Hill, I have considered it advisable to review the whole matter at the present time with the view of helping to clear up some of the difficulties which, in my opinion, have been caused by confounding the original types of Professor Morris with at least two other distinct forms.

Professor Morris describes the original type *P. odontopteroides* as follows:—

Pecopteris odontopteroides (Pl. vi., fig. 2, 3, 4). †

" Frond pinnatifidly bipinnate or flabellate; pinnæ linear, elongate, accuminate; pinnulæ opposite approximate, adnate, ovate obtuse, entire; veins nearly obliterated.

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* See pp. 188-191, "Systematic account of the Geology of Tasmania," by the Author.

† Physical description of New South Wales and Van Diemen's Land, by P. E. de Strzlecki, 1845.

"There is some difficulty in assigning this species to the proper genus, in consequence of all the specimens I have examined being imbedded in a coarse sandstone, so that the venation, with the exception of a slight central depression indicative of a mid-rib, is nearly obliterated. With some care, however, in detaching the matrix from the pinnulæ, I have been able to trace what appears to be a slight radiation in the form of the secondary veins, resembling that generally found in *Odonopteris* (whence the specific name); this may prove to be deceptive, and other specimens may perhaps better elucidate this view."

"The general contour of this fern (Pl. vi. fig. 3) somewhat resembles a single pinna of *Neuropteris conferta* (Sternb.); but the pinnules are more oblong, and the terminal one accuminate; but it still more closely approaches in form a pinna of *Odontopteris Permiensis*, a fern described from the Permian system in the work on the Geology of Russia, by R. J. Murchison, Esq.

"Presuming, on the other hand, that it forms a portion of a flabellate frond, a pinna, of which a drawing only has been seen, bears considerable affinity as to its mode of furcation to the recent species of Gleichenia flabellata, and under this point of view might be associated with the genus *Laccopteris* (Presl.) should the venation prove to be the same."

Locality: Jerusalem basin.

"A figure has also been given with more lanceolate shaped pinnular, which is probably only a variety of this species."

The above is a full account of the original description of Professor Morris' type species, which was also accompanied by three illustrations (Pl. vi., fig. 2, 3, 4).

Unfortunately in the shales of Jerusalem beds there exists a smaller dichotomous fern, which somewhat resembles the original type of Morris in the attachment of the pinnules. The pinnæ of the latter form *Thinnfeldia obtusifolia* (mihi), however, are invariably dichotomised; the pinnules are devoid of any distinct mid-rib, and are altogether smaller and less coriaceous in texture. The veins arise from a common point at the base of the pinnule, from which they diverge to margin by repeated furcations. This form, moreover, occurs in the greatest profusion in the shales of the upper mesozoic beds in Tasmania, and invariably presents the same general characteristics in widely separated localities. Forms identical in all respects with Prof. Morris' original type species are found rarely, and only occur in the coarse sandstones.

It is more than probable therefore that the examples examined subsequently by Prof. M'Coy, Messrs. Carruthers, Crepin, Etheridge, sen., Dr. Feistmantel, were identical with the smaller and more abundant dichotomous fern

(*Thinnfeldia obtusifolia*, mihi) from the mesozoic shales, and not the form from the coarse sandstones examples of which are very rare.

As an illustration of the rarity of the latter, I may state that my own experience among Tasmanian rock extends over twenty-two years, and in that time I have only obtained about a dozen specimens of Prof. Morris' original types, always in the sandstone matrix; never in the shales. All of the casts of specimens agree with Prof. Morris' originals, which are invariably coarse, never show dichotomy, and frequently the pinnules, unlike the common *T. obtusifolia*, indicate a trace of a pretty well defined mid-rib.

With such doubt respecting these two forms, which are merged together as one species by Dr. Feistmantel in his last memoir on "The coal and plant-bearing beds of Palæozoic and Mesozoic age in Eastern Australia and Tasmania, pp. 101-105." I think it advisable to retain the original name of *Pecopteris odontopteroides* (Morris) for the rarer original type until such time as we obtain better evidence as to its identity.

To aid in this direction I have figured such of the fragments of the older and rarer fern as are still in my collection (pl. ii., figs. 1-5), all of which have been obtained from the sandstones of the Jerusalem basin. Like Professor Morris' specimens, the blackened impressions alone exist. There are traces of what appear to be a well-defined mid-rib in several of the pinnules, but in no example have I seen any indication of dichotomy of the terminals of the pinnæ, so constant a character in the smaller abundant form—*Thinnfeldia obtusifolia* (mihi).

Dr. Feistmantel has also, in the memoir already referred to, included another form under *Thinnfeldia odontopteroides* (Morris), viz., figs. 1, 1^a, 1^b, 2, 2^a, 2^b, Pl. xxix; figs. 1, 1^a, 1^b, 2, 2^a, Pl. xxx., whose identity with either *P. odontopteroides* (Morris), or *T. obtusifolia* (mihi), is more than doubtful. The robust branching fern from Victoria, and New South Wales, the Hawkesbury series certainly approaches *T. obtusifolia* (mihi) in the upper pinnæ, but while I recognise the rare judgment and wide knowledge of Dr. Feistmantel, I am still doubtful whether the two forms are conspecific. The complete absence of dichotomy, in the terminal pinnæ, and the more robust character of this fine fern contrasts widely with *T. obtusifolia* (mihi), which, from the detached remains, never found in a branching connection, indicate probably repeated dichotomy, as in our existing *Gleichenia flabellata*, as suggested by Professor Morris.

For this reason I think it would be well at present to distinguish the splendid robust form from Mount Victoria by a separate name, say *Thinnfeldia Feistmantelli*, in honour of the distinguished palæontologist who has done such valuable work in the elucidation of our Australasian Fossil Flora.

OSMUNDIA.

In the leaf beds near Glenora, underlying the older basaltic plateau, of which a brief description is given in my larger work on "The Geology of Tasmania," p. 289, recent examination has enabled me to add several interesting new forms to our knowledge of the plant life of the Lower Tertiaries of this island (*Palæogene Period*).

Among these occur the more or less perfect impressions of the pinnulæ of a fern which, from their size, form, mode of attachment, and characteristic neuvation, suggest alliance with the existing genus *Osmunda.*

The absence of all knowledge regarding fructification, however, makes it hazardous now to refer it to that genus; for the form and mode of neuration also suggest alliance with certain barren pinnules of Lygodium (*Lygodium? Strzleckii* Ettings., "Tertiary Flora of Australia," Sydney, 1888), and with barren pinnules of Llavea (see *Llavea cordifolia*, Lagasca), and so cause much doubt as to its true generic position.

I have, therefore, thought it prudent in our present state of knowledge to place it under the provisional generic name *Osmundia*, under which also may be temporarily placed all *incertæ sedis* of allied characters.

PLANTÆ INCERTÆ SEDIS.

Osmundia (Nov. gen.)

Frond unknown; barren pinnules large, symmetrical oblong, or oblong-lanceolate, entire, somewhat obtusely pointed, the lower base slightly auricled; Neuration Neuropteridean; primary nerve distinct; secondary nerves acutely ascending, sharp, thin, dense, dichotomising and slightly curving towards extremeties. Horizon—Lower Tertiary Leaf-Beds, Glenora, Tasmania.

Osmundia Tasmanica. Nov. sp. (Pl. I., fig. 2).

Sp. char.—The same as the genus. Apex generally pointed and roundly-obtuse; primary nerve firm, evanescing towards apex; margin somewhat indistinct, but showing indication of serrature. Length of larger pinnules 2 inches; breadth, $\frac{5}{8}$ths of an inch.

There is every appearance that Dr. Ettingshausen's *Lygodium Strzleckii* is generically allied. The fragment of a pinnule described by this eminent authority from a similar horizon at Vegetable Creek, New South Wales, was too imperfect to determine either its position or even the character of the entire pinnule, or its mode of attachment. It would be perfectly safe, however, to refer it to the specially created genus *Osmundia* as defined by me, and I would suggest that, for the present, it be referred to as *Osmundia Strzleckii* Ettings, as a congener of the closely allied *O. Tasmanica*, mihi, occurring in the Leaf Beds of Glenora.

Phyllites salicifolium, nov. sp.

(Pl. I., fig. 3.)

Leaf imperfect, linear lanceolate accuminate, sharply serrato-dentate; mid-rib distinct; secondary nerves thin, simple, curving gently upwards, and reaching margin and forming the sharply-defined upper edge of each serrature; 13 pairs in upper half of leaf; length of complete specimen about inches; greatest width at middle about $\frac{9}{16}$ of an inch.

Horizon.—Lower Tertiary. Leaf Beds near Glenora.

Phyllites Oleaciformis, mihi.

(Pl. I,, fig. 1; also Pl. XXXVII., fig. 2. Geol. of Tas.)

Leaf imperfect, ovate; margin distantly serrato-dentate; mid-rib distinct; secondary nerves—14 pairs—obscure, fine, simple, hidden in a somewhat coriaceous integument, and gently curving upward, reaching upper margin of each serrature; surface covered regularly with small round glandular dots.

Length complete, 2¼ inches; greatest breadth at middle, 1 inch.

Horizon.—Occurring with the previous species.

Banksia lancifolia. Ett.

(Pl. I., fig. 4.)

Although only a fragment, the characters of this leaf impression are in all respects identical with a form under the above name described by Ettingshausen ("Tertiary Flora of Australia," p. 141, Pl. xii., fig. 15) from a specimen obtained at Old Rose Valley Lead, N.S. Wales. The following is the description given of the complete specimen:—

"*Banksia lancifolia. Sp. char.* B. foliis petiolatis coriaceis anguste lanceolatis, basi acutis, apicem versus sensim attenuatis, margine spinoso-serratis; nervatione brochido-craspedodroma; nervo primaris valido, prominente; nervis secundariis subangulis 55-56° orientibus, tenuibus subarcuatis, approximatis; nervis tertiariis rectangularibus, dictyodromis; rete microsynammato tenerrimo."

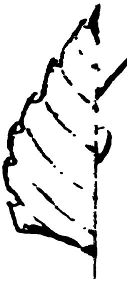
. . . Approaches near to the *Banksiæ* of the European Tertiary Flora.

Locality and Horizon.—Old Rose Valley Lead, N.S. Wales; Glenora Leaf Beds, Tasmania.

In part II., now under preparation, will be described a number of new and interesting plant forms, discovered in collections sent to me by the Rev. J. Bufton, F.L.S., of Dunally, from Mesozoic shales in that locality.

Geologists, as well as the writer, are indeed much indebted to this accomplished naturalist for the skill and commendable energy he has displayed in enriching our knowledge of the fossil plants of this island by his numerous collections in that part of the country in which he now resides.

Pl. ii.



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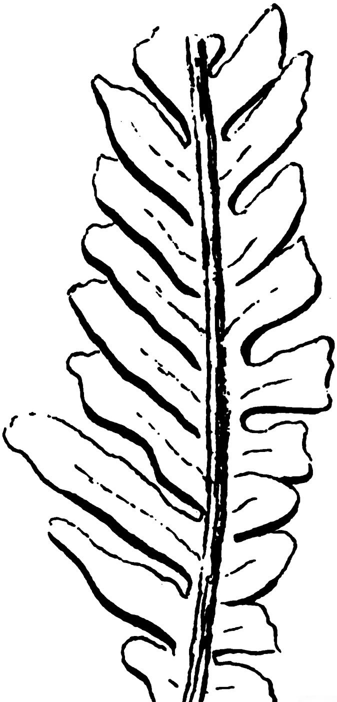

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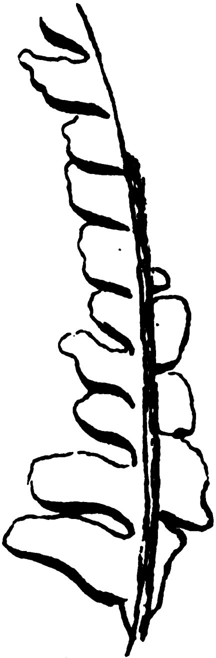

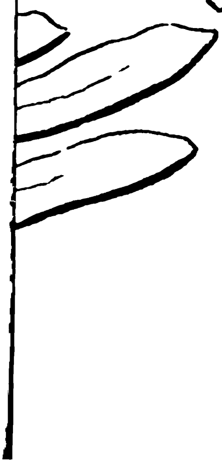

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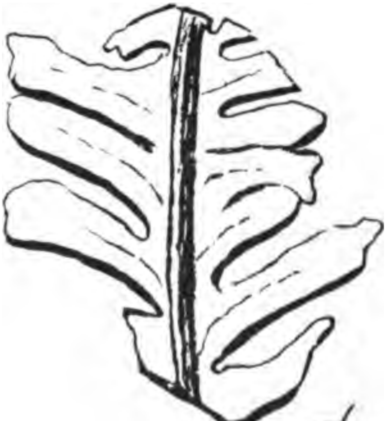

BOTANICAL NOTES.

By L. Rodway.

(Plates.)

Coprosma moorei, F. v. M.—About two or three years ago Mr. T. B. Moore discovered in the vicinity of Mount Tyndall a small plant with a conspicuous blue berry, evidently a Coprosma, or closely allied to that genus. Baron von Müeller, to whom it was sent, could not, in the absence of flowers, safely identify it, but considered it probably *C. Petriei* (Chess) of New Zealand, and a paper to that effect appears in our transactions for 1891. In December, 1892, I was fortunate enough to find the plant in quantity, and, more fortunate than my friend, Mr. Moore, I discovered it in full flower. The plant was submitted to Baron von Müeller and Mr. Petrie, of Dunedin, and its distinctness from *C. Petriei*, or from any plant hitherto described, was thoroughly apparent. With von Müeller's sanction, I have described it under the name of its original discoverer. There is one point that renders the plant of unusual interest, namely, its hermaphrodite flowers, a unique development in Coprosma, uniting that genus, as von Müeller had already suggested, with *Nertera*. From the latter, however, our plant differs in the 4-lobed calyx and the insertion of the stamens.

A small prostrate, creeping, glabrous perennial; stems branching, rooting at intervals, sometimes almost entirely subterranean. Leaves ovate to ovate-lanceolate, spreading, thick, shining, concave, acute, narrowed into a short petiole, mostly 1¼ to 2½ lines long. Stipules interpetiolar with 2 minute subulate erect lobes at the junction. Flowers terminal, sessile, terminating short erect branchlets, hermaphrodite. Calyx broadly oblong, about 1 line long, slightly compressed below the lobes; lobes 4, broad, acute, rather less than half as long as the tube. Carolla campanulate, about 1 line long, lobes 4, broad acute, nearly as long as the tube. Stamens 4, free from the carolla, and inserted at its base. Filaments slightly exceeding the carolla. Anthers erect ovate, slightly apiculate. Style divided nearly to the base into 2 filiform papillose branches, about half again as long as the stamens, and maturing rather before they are fully developed. Ovary 2 celled. Fruit blue, broadly oval, 3 lines long, crowned by the persistent calyx-lobes. Pyrenes 2, pale brown, smooth, broadly ovate, but flattened on one side, suspended from the top of the inflated mesocarp; each one seeded. Embryo minute in a copious albumen. (Plate I.)

Near Mount Tyndall; Snake Plains, Mount Wellington; Cutting Grass Swamp, Mount Arthur, near New Norfolk.

Actinotus bellidioides (B).—This plant is no less remarkable for the peculiar suppression of one mericarp than for its extreme variability. J. D. Hooker, in *Lond. Journ.* vi., 471, described four species, *Hemiphues affinis, tridentata, bellidioides*, and *suffocata*. In the Flora Tasmanese he combinse them under the name *H. bellidioides*, and he there figures one variety, *var. fulva* with petals, a development that is received in doubt by most botanists. The material he had at his command was meagre, and though we are not now supplied with a perfect series, we have forms that would probably have modified his views. Bentham transferred the species to the genus *Actinotus*. In all forms hitherto described the leaves are either entire or crenate on the margin. I have now in my possession a form rather more robust than most specimens, with the leaves palmately divided nearly to the petiole into 3 or 5 lanceolate segments, otherwise it does not differ from the type of *A. bellidioides*; it was found on Mount Tyndall by T. B. Moore. The variety figured by Hooker as *var. suffocata* was, unfortunately, in advanced fruit only. My friend Wm. Fitzgerald has put me in the position to examine the plant in all stages, and its constant dwarf habit, total absence of calyx-limb, and reduction of stamens to 2 only, warrant us in considering it specifically distinct.

Actinotus suffocata.—Very similar in habit and detail to the smaller forms of *A. bellidioides*, but still smaller. Leaves oblong, glabrous entire, 1 to 2 lines long on a hairy petiole as long as itself. Peduncle half-inch long, slender, bearing a small head 1½ lines diameter, bracts about 8 or 10. Flowers about 6 to 10. Calyx-limb none. Petals none. Stamens 2, articulate opposite the styles. Fruit about half-line long. Mount Dundas, and other mountains in the vicinity. (Plate II.)

Isoëtopsis graminifolia (Turez).—This peculiar and interesting little isoëtes-like composite constitutes the sole member of the genus, and has hitherto been found in Southern and Eastern Australia only. I have lately found it rather abundantly on grassy hills about Hobart. Baron von Müeller, who kindly identified it for me, is of the opinion that it is certainly endemic.

Helichrysum obtusifolium (F. v. M., et Lond.).—A perennial everlasting, but often flowering the first year so as to appear annual. It has the appearance and details otherwise of *H. dealbatum* except that the leaves and flower-heads are smaller; in these details it approaches our southern perennial, *H. Spiceri*, which, however, has still smaller flowers. Baron von Müeller wishes me to introduce the plant in this paper. It was lately found at Clarke Island by Mrs. McLaine.

Viola Sieberiana (Spreng.).—An old established species, which has been reduced to a variety of the very variable *V. hederacea Lab.*, but apparently without sufficient justification. Though doubtless closely allied to that species in Tasmania, at least, its habit is distinct. Mr. Fitzgerald, who kindly supplied me with considerable material, tells me it is common in localities near George's Bay, where it grows in conjunction with, but always distinct from, *V. hederacea.*

Habit tufted and stoloniferous. Leaves rhomboid to ovate, crenate, ½ to ¾in. long, on long slender petioles; stipules adnate at the base, brown, lanceolate, acute, denticulate on the margin. Scapes shorter than the leaves, elongating after flowering. Petals narrow, linear, 1½ lines long. Seeds white or black. Other details agreeing with *V. hederacea.* (Plate II.)

Australina müelleri (Wedd.).—A much more robust plant than *A. pussila* (Gand.), with a different habit and foliage, but similar inflorescence, was reduced to a variety chiefly from their being found at distinct localities. On the southern slopes of Mount Wellington they grow together without any tendency to converge.

Saponaria tuberlosa (F. v. M.).—This rare plant has been found near George's Bay Heads by Wm. Fitzgerald; only few specimens were procurable, and he considered this, together with some rare eastern Australian sedges in the same locality, might have been transported by migrating ducks.

Eucalyptus perriniana (F. v. M.). was described at the meeting of the Association for the Advancement of Science at Melbourne, from specimens procured from immature trees not yet in flower. It is a Eucalypt that has long been known in the Hamilton and, I believe, one or two other districts, and an effort has often been made to learn its affinity; but in the absence of flowers and fruit this was not possible. The kindness of Rev. Mr. Dicker and Superintendent Hedberg has placed at my disposal various specimens in different stages; but we are still in want of some mature information desirable before forming a definite opinion. The tree, where hitherto observed, has a decidedly bushy habit, grows in a copse, and only attains 10 to 20 feet high. The trees are only now attaining maturity. The leaves, till a year or two ago, were all opposite, connate and orbicular; upon the trees attaining a height of 10 to 15 feet the leaves became alternate, petioled, and lanceolate, with exactly the form and venation of some forms of *E. viminalis.* The flowers commenced to develop in the upper opposite leaves, and continued more numerously in the axils of the alternate ones, and appear always in threes. The flowers, stamens, and fruit appear in no detail to differ from the small flowering forms of *E. viminalis*, and I should feel disposed to think that *E. perriniana* bore the same relation to that species that *E. risdoni* does to *E. amygdalina.*

Gahnia graminifolia.—I referred to this species in a paper read before the Society last year, where it appears under the name given it by Baron von Müeller, *G. rodwayi.* For various reasons I have preferred to change its name. The plant has unusual interest to a botanist from the graminaceous nature of its leaf-sheaths, a peculiarity noticeable in most members of the genus, but here carried further, and from its panicle flowering immediately upon elongation, while the glumes are still succulent and green instead of waiting till the next spring, or at least till the glumes are indurated, a detail unique, at least amongst Tasmanian allies.

A small densely-tufted plant forming pulvinate masses, often 1 to 2 feet diameter. Stems very short, seldom exceeding 3 inches, numerous from a much-branched, intricately spreading rhizome. Leaves flat, grassy, and spreading 3 to 8 inches long, 2 lines wide, becoming very narrow towards the apex; margin entire, involute when dry; the sheathing base arising from a node, split and bearing a distinct ligule at the orifice. Panicle flowering immediately as it elongates 1 inch long; spikelets few, in distant narrow clusters, each cluster in the axil of a leaf or leaf-like bract, each spikelet pedicelled and subtended by a glume-like bract, 2 to 3 lines long, narrow, lanceolate. Flower solitary, terminal hermaphrodite. Glumes generally 5, succulent at flowering, subsequently membranous ciliate on the heels and margin, and often also on the surface, gradually smaller from without inwards, 2 outer ones lanceolate obtuse, 3 inner ones orbicular closely imbricating, the innermost one small, and closely enveloping the flower. Stamen solitary, filament long, sub-persistent. Style, long, slender, divided nearly to the base into 3 branches, nut ovoid oblong 1 to 1½ lines long, nearly black, polished, obtusely 3 angled; inner surface of pericarp smooth, with very faint indications of transverse rugæ.

On hills from Huon-road to Mount Nelson.

Lepidosperma inops, (F. v. M.).—Introduced also in the same paper, though very distinct in habit, is probably an extreme variety of *L. lineare* (R. Br.). In very few of the Tasmanian species of this difficult genus is much reliance to be placed no habit.

Lepidosperma lineare, var. inops.—Plant densely clustered, 2 to 4 inches high, stems and leaves nearly flat, ½ to ¾ line wide. Panicle reduced to 2 or 4 spikelets on short stems, the bracts leafy, the outer one erect, and often 2 inches long.

Hills south of Waterworks, Hobart.

Restio oligocephalus (F. v. M.).—There has always appeared a considerable amount of confusion about this interesting

Tasmanian plant, chiefly through its extreme variability not being recognised. One of its forms that I here refer to as *var. glabrum* would certainly deserve to be considered distinct were it not for the numerous intermediate forms.

Stems erect from a creeping rhizome, simple at least below the inflorescence, 6 inches to 1 foot high; bracts sheathing but loose, smooth, ½ to ¾ inches long, with a truncated usually woolly apex. Spikelets usually few in an interrupted spike or rarely panicle, sometimes solitary. Males ¼ to ½ inch long, narrow oblong, the glumes with a woolly tip when young. Perianth flat, about 2 lines long, the outer side segments complicate, heeled, and woolly towards the apex. Females broadly oblong to spherical, ¼ inch long; perianth 1½ lines long, side segments complicate but not heeled; ovary about 1 line long with very short curved styles, flat. Staminodia seldom present.

Syn. R. monocephalus (R. Br.).

Common on damp heaths.

Var. intermedius.—Similar to the type, only the female as well as the male spikelets are narrow-oblong, and the styles are about as long as the ovary, often attaining 1 to 2 feet, and generally much branched.

Kingston, Longley, etc.

Var. glabrum.—Similar in general details to the type, but without the woolly tips to the bracts, glumes and perianth segments; seldom exceeding 6 inches, and fairly consistently bearing but one spikelet. Bracts sheathing at the base, but loose and spreading, striate ½ to ¾ inch long; the apex 3-lobed, the central lobe 1 to 3 lines long, subulate, the side ones shorter and membranous. Spikelets as in the type, but both sexes narrow-oblong. Male perianth about 1 line long, flat. Female perianth about 1 line long, the outer segments slightly complicate; ovary ½ to ⅓ line long, the style, long, slender, much exceeding it. Staminodia always present.

Near Kingston, on wet heaths.

ON THE AFFINITY OF THELYMITRA IXIOIDES AND ITS ALLIES.

This group of terrestrial orchids, commonly termed native Hyacinth, consists of very numerous forms, differing but slightly from one another. As in all variable groups, this has given rise to numerous names adopted for marked variations, many of which research has rendered obsolete. In the present day the tendency is to follow Bentham and Müeller, and sort the group immediately related to *T. ixioides* into six species, namely:—*T. ixioides*, Suz.; *T. aristata*, Lind.; *T. longifolia*, Forst.; *T. carnea*, R. Br.; *T. cyanea*, Lind.; and *T. venosa*, R. Br. None of these can be considered well fixed same relation to that species that *E. risdoni* does to *E. amygdalina.*

Gahnia graminifolia.—I referred to this species in a paper read before the Society last year, where it appears under the name given it by Baron von Müeller, *G. rodwayi.* For various reasons I have preferred to change its name. The plant has unusual interest to a botanist from the graminaceous nature of its leaf-sheaths, a peculiarity noticeable in most members of the genus, but here carried further, and from its panicle flowering immediately upon elongation, while the glumes are still succulent and green instead of waiting till the next spring, or at least till the glumes are indurated, a detail unique, at least amongst Tasmanian allies.

A small densely-tufted plant forming pulvinate masses, often 1 to 2 feet diameter. Stems very short, seldom exceeding 3 inches, numerous from a much-branched, intricately spreading rhizome. Leaves flat, grassy, and spreading 3 to 8 inches long, 2 lines wide, becoming very narrow towards the apex; margin entire, involute when dry; the sheathing base arising from a node, split and bearing a distinct ligule at the orifice. Panicle flowering immediately as it elongates 1 inch long; spikelets few, in distant narrow clusters, each cluster in the axil of a leaf or leaf-like bract, each spikelet pedicelled and subtended by a glume-like bract, 2 to 3 lines long, narrow, lanceolate. Flower solitary, terminal hermaphrodite. Glumes generally 5, succulent at flowering, subsequently membranous ciliate on the heels and margin, and often also on the surface, gradually smaller from without inwards, 2 outer ones lanceolate obtuse, 3 inner ones orbicular closely imbricating, the innermost one small, and closely enveloping the flower. Stamen solitary, filament long, sub-persistent. Style, long, slender, divided nearly to the base into 3 branches, nut ovoid oblong 1 to 1½ lines long, nearly black, polished, obtusely 3 angled; inner surface of pericarp smooth, with very faint indications of transverse rugæ.

On hills from Huon-road to Mount Nelson.

Lepidosperma inops, (F. v. M.).—Introduced also in the same paper, though very distinct in habit, is probably an extreme variety of *L. lineare* (R. Br.). In very few of the Tasmanian species of this difficult genus is much reliance to be placed no habit.

Lepidosperma lineare, var. inops.—Plant densely clustered, 2 to 4 inches high, stems and leaves nearly flat, ½ to ¾ line wide. Panicle reduced to 2 or 4 spikelets on short stems, the bracts leafy, the outer one erect, and often 2 inches long.

Hills south of Waterworks, Hobart.

Restio oligocephalus (F. v. M.).—There has always appeared a considerable amount of confusion about this interesting

Tasmanian plant, chiefly through its extreme variability not being recognised. One of its forms that I here refer to as *var. glabrum* would certainly deserve to be considered distinct were it not for the numerous intermediate forms.

Stems erect from a creeping rhizome, simple at least below the inflorescence, 6 inches to 1 foot high; bracts sheathing but loose, smooth, $\frac{1}{2}$ to $\frac{3}{4}$ inches long, with a truncated usually woolly apex. Spikelets usually few in an interrupted spike or rarely panicle, sometimes solitary. Males $\frac{1}{4}$ to $\frac{1}{2}$ inch long, narrow oblong, the glumes with a woolly tip when young. Perianth flat, about 2 lines long, the outer side segments complicate, heeled, and woolly towards the apex. Females broadly oblong to spherical, $\frac{1}{4}$ inch long; perianth $1\frac{1}{2}$ lines long, side segments complicate but not heeled; ovary about 1 line long with very short curved styles, flat. Staminodia seldom present.

Syn. R. monocephalus (R. Br.).

Common on damp heaths.

Var. intermedius.—Similar to the type, only the female as well as the male spikelets are narrow-oblong, and the styles are about as long as the ovary, often attaining 1 to 2 feet, and generally much branched.

Kingston, Longley, etc.

Var. glabrum.—Similar in general details to the type, but without the woolly tips to the bracts, glumes and perianth segments; seldom exceeding 6 inches, and fairly consistently bearing but one spikelet. Bracts sheathing at the base, but loose and spreading, striate $\frac{1}{2}$ to $\frac{3}{4}$ inch long; the apex 3-lobed, the central lobe 1 to 3 lines long, subulate, the side ones shorter and membranous. Spikelets as in the type, but both sexes narrow-oblong. Male perianth about 1 line long, flat. Female perianth about 1 line long, the outer segments slightly complicate; ovary $\frac{1}{2}$ to $\frac{1}{3}$ line long, the style, long, slender, much exceeding it. Staminodia always present.

Near Kingston, on wet heaths.

On the Affinity of Thelymitra Ixioides and Its Allies.

This group of terrestrial orchids, commonly termed native Hyacinth, consists of very numerous forms, differing but slightly from one another. As in all variable groups, this has given rise to numerous names adopted for marked variations, many of which research has rendered obsolete. In the present day the tendency is to follow Bentham and Müeller, and sort the group immediately related to *T. ixioides* into six species, namely:—*T. ixioides*, Suz.; *T. aristata*, Lind.; *T. longifolia*, Forst.; *T. carnea*, R. Br.; *T. cyanea*, Lind.; and *T. venosa*, R. Br. None of these can be considered well fixed species, though *T. venosa* approaches that condition. The first three can at best be considered names of convenience to group the very numerous forms of one variable species. *T. carnea* is a well marked species in the type, but is intimately connected to *T. ixioides* by intervening links, and *T. cyanea* forms an intermediate species between *T. ixioides* and *T. venosa.* The flowering period of the first five species is the same, namely, October and November, and they grow usually together, except that *T. cyanea* shows a partiality for damp situations. The flowering period of *T. venosa* is December and January. In most descriptions the habit in reference to degree of robustness is relied on as an aid to identification, but an intimate acquaintance has completely destroyed that assistance. In all, except the typical form of *T. carnea,* specimens may be found from a few inches high to nearly two feet, and from an excessively slender state, with an almost filiform leaf grooved on the upper surface to a thick robust condition, with a broad, thick, fleshy leaf, concave above, and from bearing one flower to a raceme of 8 to 12. *T. carnea* has a marked habit, distinguishing it from the other members of this group, namely, that the stem is bent at each bract, and in a totally unreliable degree. *T. venosa* is usually a more robust species than *T. cyanea* and *T. aristata,* with large forms of *T. ixioides,* are more robust than the common forms of *T. longifolia.* In size and colour of perianth there is little really reliable. *T. ixioides* may be blue, pink, or rarely white, it is often spotted with dark blue, or dark pink, but not always so. *T. aristata* and *longifolia* has a pale blue to white perianth without spots or veins. *T. carnea* has a fleshy-pink perianth, but in varieties approaching *T. ixioides,* it is spotted with dark pink or blue. *T. cyanea* and *T. venosa* has a blue, pink, or white perianth, veined with darker colour; the column also is striped with dark coloured bands. In all the perianth varies from 4 to 10 lines long, the greatest variation being found in *T. ixioides* and *T. aristata.*

The only other means of distinction at our disposal, namely the shape of the column, yields but little evidence to favour the right to consider all these forms as reliable species.

The column in this group is short. The stigma is peltate and near the base, and the anther varies inversely as the development of the column-wing from small, and placed close above the stigma at the back of the rostellum to large and protruding and freely removed above the stigma. The column is surrounded at the sides and base by a comparatively broad wing that is continued at the back, and more or less above the anther into variously formed lobes or processes. In *T. venosa* the wing is not continued behind the anther, but ends in two narrow lobes bent forwards and

PLATE I.

Coprosma moorei, F. v. M.

1. Natural size.
2. Flower, etc.
3. Leaf.
4. Flower, young.
5. " " corolla and a portion of calyx removed to show insertion of stamens.
6. Stamens.
7. Pollen.
8. Fruit in section, pyrenes *in situ.*
9. Pyrenes removed to show partial dissepiment.
10. Pyrenes.
11. " section.

PLATE II.

Actinotus suffocata.

1. Natural size.
2. Umbel.
3. Leaf.
4. Flower.
5. Fruit.

Viola sieberiana, Spreng.

1. Natural size.
2. Stipules.
3. Flower.
4. Corolla and part of calyx removed.
5. Stamen, upper.
6. " lower.
7. " " side view.

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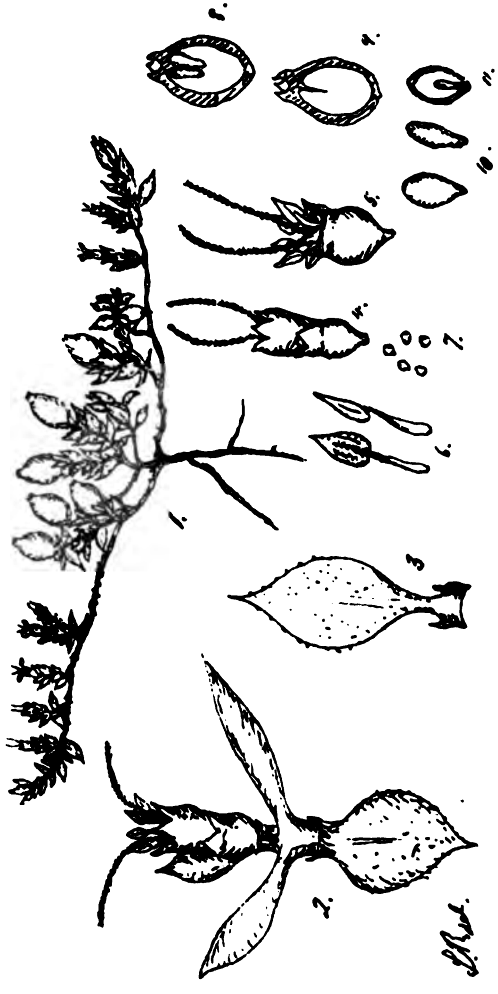

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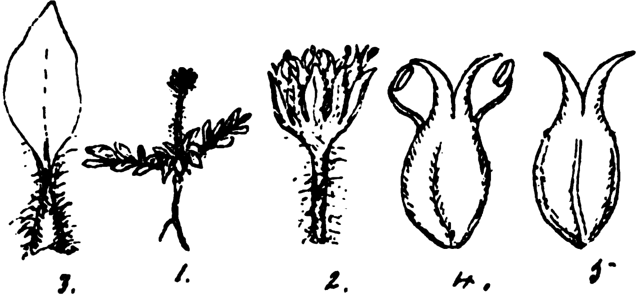

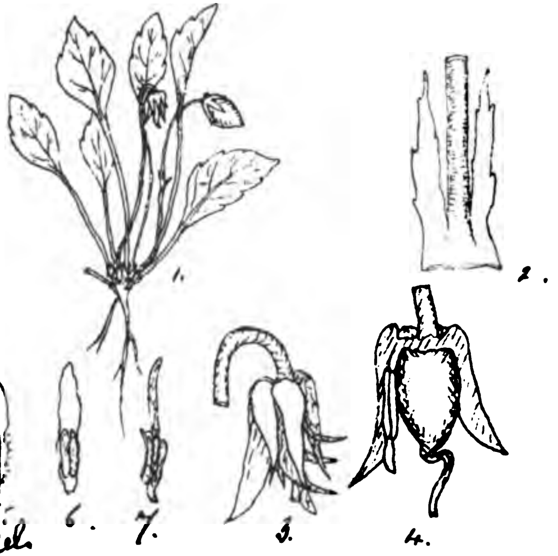

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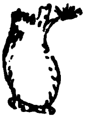
Pl. III.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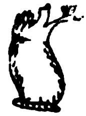
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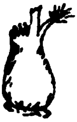
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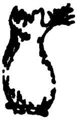
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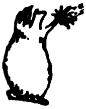
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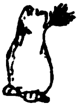
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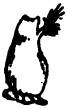
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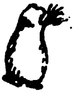
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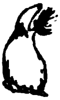
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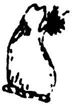
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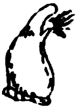
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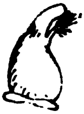
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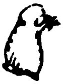
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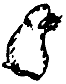
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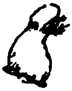
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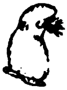
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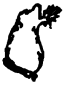
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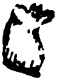
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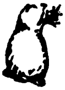
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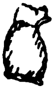
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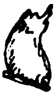
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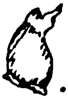
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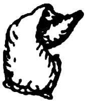
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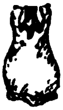
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spirally twisted (figs. 23 and 24). In *T. cyanea* these lobes are reduced in length, are straight and irregular in outline, and have usually a papillose development low down on their anterior margin. The wing is continued behind the anther as a papillose projection (figs. 21 and 22). In the typical forms of *T. carnea* the side lobes are reduced to papillose ovate processes, and the posterior portion of the wing is further developed into a thick papillose wall behind the anther (Fig. 20). In the intermediate forms connecting this with *T. ixioides*, the side lobes develop copious penicillate adornment, and the posterior lobe correspondingly approaches the form found in that species (figs. 17, 18, and 19). In the typical form of *T. ixioides* the side lobes are linear, projected forwards in front of the anther, and terminate in a copious penicillate brush; the posterior lobe is divided into three portions, a small erect sub-quadrate process on each side, and a very short roughly papillose centre (figs. 1, 2, and 3). Every intermediate stage between this and the form termed *T. aristata* may be freely met with (figs. 4 to 7). In *T. aristata* the three portions of the posterior lobe have further developed and coalesced, but is usually deeply notched or split in the central line. The extent of development is most variable, but the margin is thin, and often papillose, and the substance not thickened (figs. 8 to 12). In *T. longifolia* the posterior lobe has developed into a thick fleshy hood, with a plain or notched thick margin. This form passes gradually from an advanced form of *T. aristata* (figs. 13 to 16).

The examination of these forms would lead us to conclude that *T. ixioides*, *T. aristata*, and *T. longifolia* are but characteristic states of a most variable species. *T. carnea* is a fairly marked species, but the links connecting it with *T. ixioides* still exist. *T. cyanea* is near to, but distinct from, *T. ixioides*; and *T. venosa*, is a fairly well marked species, certainly further removed from *T. cyanea* than that species is from *T. ixioides*.

The following is a description of sundry details of the plants whose columns are shown in the Plate III.

The sketches are 2½ to 3 times natural size.

Fig. 1.—18 inches high, robust. Leaf thick, broad, ribbed, 9 inches long. Raceme of 7 flowers. Perianth 7 lines long, blue and pink, spotted with dark blue.

Fig. 2.—10 inches high, slender. Leaf thick, slender, 5 inches long. Raceme of 3 flowers. Perianth 7 lines long, blue and pink, without spots or stripes.

Fig. 3.—7 inches high, slender. Leaf thick, slender, 4 inches long. Raceme of 2 flowers. Perianth 4 to 5 lines long, pink, spotted with blue.

Fig. 4.—14 inches high, fairly robust. Leaf thick, broad, ribbed, 7 inches long. Raceme of 2 flowers. Perianth 9 lines long, blue and pink, spotted with dark blue.

Fig 5.—9 inches high, slender. Leaf 5 inches thick, slender. Raceme of 2 flowers. Perianth 4 lines long, pale blue and pink, slightly veined with darker blue.

Fig. 6.—13 inches high, rather robust. Leaf 6 inches long, rather thick, broad. Raceme of 3 flowers. Perianth 5 lines long, blue, slightly veined.

Fig, 7.—9 inches high, slender. Leaf 4½ inches long, thick, slender. Raceme of 2 flowers. Perianth 4 lines long, blue, without spots or veins. Column hood split.

Fig. 8.—Similar to 7, but rather more robust. Perianth spotted. Column hood deeply emarginate.

Fig. 9.—18 inches high, robust. Leaf 8 inches long, thick, not broad, but ribbed. Raceme of 7 flowers. Perianth 9 lines long, pale blue. Column hood truncate, papillose at end.

Fig. 10.—24 inches high, robust. Leaf 10 inches long, thick, broad, ribbed. Raceme of 13 flowers. Perianth 10 lines long, pale blue. Column hood truncate, papillose.

Fig. 11.—10 inches high, slender. Leaf 5 inches long, rather broad, thick. Raceme of 4 flowers. Perianth 5 lines long, pale blue and pink. Column hood slightly thickened with a plain emarginate apex.

Fig. 12.—6 inches high, very slender. Leaf 3 inches long, very slender. Flower solitary. Perianth 3 to 4 lines long, pale blue and pink. Column hood thick, emarginate.

Fig. 13.—8 inches high, rather robust. Leaf broad, thick, ribbed, 4 inches long. Raceme of 3 flowers. Perianth pale blue, 6 lines long. Column hood thick, emarginate.

Fig. 14.—18 inches high. Raceme of 7 flowers. Perianth 8 lines long, otherwise similar to 13.

Fig. 15.—Flower solitary. Column hood truncate, but not emarginate, otherwise similar to 13.

Fig. 16.—7 inches high, slender. Leaf 3 inches long, thick, slender. Raceme of 2 flowers. Perianth very pale blue, 8 lines long. Column hood large, fleshy, thick.

Fig. 17.—16 inches high, rather robust, flexed at bracts. Leaf 8 inches long, thick, rather broad, ribbed. Raceme of 8 flowers. Perianth 7 lines long, pink, spotted with blue.

Fig. 18.—11 inches high, rather robust, flexed at bracts. Leaf thick, rather broad, ribbed, 6 inches long. Raceme of 4 flowers. Perianth 6 lines long, pink. Column wing shortly papillose, penicillate on sides of posterior lobe as well as on lateral lobes.

Fig. 19.—9 inches high, slender, slightly flexed at bracts. Leaf slender, 4 inches long, thick. Raceme of 2 flowers. Perianth 7 lines long, pink. Column wing but slightly differing from undisputed forms of *T. ixioides*.

Fig. 20.—8 inches high, slender, flexed at bracts. Leaf thick, slender, 4 inches long. Flower solitary. Perianth 5 lines long, pink. Column wing with ovate papillose, lateral lobes, and truncate papillose, posterior lobe. Anther slightly protruding.

Fig. 21.—12 inches high, slender, robust. Leaf 5 inches long, thick, broad, ribbed. Raceme of 3 flowers. Perianth 5 to 6 lines long, blue, veined with darker blue. Column with a truncate-papillose posterior lobe and 2 subulate-lanceolate, irregular, lateral lobes. Anther raised some distance above the stigma, and protruding between the lateral lobes.

Fig. 22.—Similar in habit to 21, slightly differing in structure of column wing.

Fig. 23.—18 inches high, slender. Leaf thick, rather broad, ribbed. Raceme of 4 flowers. Perianth 7 lines long, blue, veined with darker blue. Lateral lobes of column wing lanceolate, convolute; posterior lobe obsolete or absent

Fig 24.—Posterior view of same.

REMARKS UPON THE DISPOSAL OF THE SEWAGE OF HOBART.

BY A. MAULT, CONSULTING ENGINEER TO THE METROPOLITAN DRAINAGE BOARD.

Read at Special Meeting, May.

A great deal of the discussion that has taken place upon the subject of the suggested methods of disposing of the sewage of the Metropolitan Drainage Area has been based upon ignorance of what has been proposed, and of the conditions under which the proposals have been made.

I have suggested three methods for the disposal of the sewage:—First, its purification by filtration through land at an irrigation farm; second, its purification by precipitation; and third, its discharge, after being screened, into the tideway of the Derwent. The irrigation system would cost about £125,000 for works, and would entail a yearly charge of about £12,000, which would necessitate a yearly rate of 10d. in the £1. The precipitation scheme would cost about £86,000, with a yearly charge of £10,500, and a rate of 8½d. in the £1. The direct discharge would cost £70,500, with a yearly charge of £7,500, or a rate of 6d. in the £1. Up to a certain point there are works needed in common by all the systems—the sewers must be built for collecting the sewage, and there must be some outfall work, and some pumping power provided. When this common work is done, the direct discharge may be carried out without any additional work. But if the precipitation scheme be adopted, it would be necessary to add to the work already done some large tanks, and some more pumping power. Or if the irrigation scheme be adopted, it would be necessary to add yet more pumping power, and to provide and prepare land, and to lay down pumping mains. Consequently no money would be wasted by completing the direct discharge system first; that is to say, either of the other systems could then be adopted by expending the difference between £70,500 and £86,000 in the one case, and between £70,500 and £125,000 in the other. I have, therefore, suggested that this direct discharge be tried first, as either of the others could be adopted without loss should it be found necessary. The following remarks are, therefore, to be taken—not as maintaining that direct discharge is in the abstract the best way to dispose of the sewage—but as showing that here the experiment of such discharge may be safely made; and that it would be unwise to proceed to further expenditure upon works until that experiment has been made, and seen to be unsuccessful.

With respect to what it is proposed to do, if the suggested plan for discharging the sewage without treatment into the estuary of the Derwent be adopted, the following are the facts:—There would be discharged into the tideway off Macquarie Point a quantity of sewage, estimated to amount in dry weather to 890,000gals. a day, about 4,000 tons. This means, if the sewage be similar in character to that of water-closet towns in England, that there will be there a daily discharge of less than three tons (6,418lb) of solid matters in solution, and of less than two tons (3,973lb.) of solid matters in suspension. Of the solid matters the noxious element may be said to be represented by 692lb. of nitrogen in solution, and 1,823lb. of organic matter in suspension. I have taken the Macquarie Point outfall as by far the principal one. Six times as much sewage will be discharged there as at Battery Point, and eight times as much as at the New Town outfall.

With respect to the conditions under which the discharge will be made; in the first place, as to the matter discharged, it will be seen that the greater part of it is in solution; as to the rest of it, it will be screened so that all floating matter with a greater dimension than half an inch will be kept back and not discharged into the Derwent at all. In the second place, as to the recipient of this discharge, it is diluted sea water, the volume of which, in what may be considered the immediate basin of discharge, is about 60,000,000 tons; one fifteenth part of which, say four million tons, is, on an average, displaced and replaced every tide; and the dilution of which is caused by a mean daily inflow of about 16 million tons of land water. In the third place, as to the point of discharge, it is into the tideway—that is into a place where it will be directly affected and acted upon by the displacement and replacement caused by every tide, and by the inflow of land water, the joint forces of which will secure the commixture of the matter discharged with the recipient water, and also its downward flow towards the sea.

In connection with the second and third of the above-mentioned conditions, it should be mentioned that tidal action, though varying throughout a lunation, may be taken to be regular with regard to the lunations throughout a year. On the other hand, the inflow of land water varies greatly from the mean quantity stated. In April, 1884, in connection with work at Meadow Banks, the Hon. N. J. Brown told me that the Derwent was lower than either he or his manager had ever noticed it. I estimated that there was then passing 1,925,000 tons of water a day, say one-eighth of the mean daily flow. As this quantity is deduced from gaugings above the mouths of the Russell Falls, Styx, Plenty, Lachlan, Sorell, and Jordan Rivers, and numerous smaller streams, I think it safe to say that the minimum flow of land water past Hobart is not less than 2,000,000 tons a day. On the 23rd September in that year there was the greatest flood I ever saw in the Derwent, and in a paper I read before the Royal Society in that year, I find that I estimated from such calculations as were possible in the case, that 216,000,000 tons of water passed New Norfolk that day. As higher floods have been known, probably more than twelve times the mean daily quantity of land water sometimes passes Hobart in 24 hours. But whatever may be the fluctuations in the daily flow, it is certain that this daily flow must be of immense volume, as it represents the drainage of about 1,400,000 acres of "wet" area with a mean rainfall of more than 55in., and of more than a million acres of "dry" area with a mean rainfall of more than 20in. The consequent dilution of tidal water is clearly shown in the analysis given further on.

Taking into consideration the facts above given in connection with the conditions stated, the following deductions are evident:—1. That the noxious matter to be discharged is infinitesimally small in quantity when compared with the volume of water into which it falls. Taking the volume of the basin immediately in front of Hobart, the daily proportion would be less than one part in 28 million parts. Supposing the water of this basin to be drinking water, the addition of this quantity of polluting matter would take several months to reduce it, even if it were not being renewed, below the standard of purity for potable water as fixed by the Rivers Pollution Commissioners in England; consequently, as it is not drinking water, its addition cannot appreciably affect the Derwent.

2. That as none of the matter to be discharged will be floating matter of the character described as being cast ashore by winds or currents at Sandy Bay, the fact that such matter is there cast ashore has nothing to do with the question of what will become of the thin liquid sewage that will be discharged at Macquarie Point. If this does not affect the water of the basin into which it is to be immediately discharged, it certainly cannot affect the water of Sandy Bay still further off.

These are not merely theoretical deductions, but practical ones, of which the truth is capable of proof, and is being proved every day at Hobart. The Hobart Rivulet is, as everybody knows, in fact, and by statute law, the common sewer of the city; and it must be borne in mind, in considering the following facts, that it discharges itself into Sullivan's Cove 600yds. further inland than the point of discharge into the tideway of the proposed new main sewer. On the mornings of the 4th, 5th, and 6th of January, during dry weather, I gauged the water passing under Campbell-street bridge, and the mean of the gaugings gave a daily flow of 2,240,000 gallons, or 10,000 tons. As these gaugings were taken above the inflow of the Park-street rivulet, they may be safely taken as showing a mean dry weather flow not exceeding the reality. Samples of the water were carefully taken at the same time. These samples certainly did not err in aggravating the impurity of the water, as, on the contrary, large floating impurities, such as a dead rat and filth that is better left nameless, could not be taken into the sample bottles. If they could have been, the samples would assuredly have shown a larger quantity of "organic matter in suspension." For the purpose of ascertaining the effect of the discharge of the Rivulet into the Cove, samples of the Cove water were taken at 13 yards from the mouth of the Rivulet, 100 yards from its mouth, and at a point 150 yards from the end of Elizabeth-street pier, and 450 yards from the mouth of the Rivulet. A sample was also taken in mid-stream of the Derwent, being half-way between Macquarie and Kangaroo Points. The following figures, all reduced to grains in the gallon of water, are the results of the Government Analyst's examination of these samples. I am greatly indebted to him for all the trouble he took in the matter. For purposes of comparison there are added the means of a large number of analyses of samples of sewage collected for the Royal Commission on Rivers' Pollution from more than thirty towns supplied with water closets; and of ordinary sea-water—the particular sample analysed—taken in the English Channel, but, as is well known, the composition of sea-water varies but little all over the world:—

CONSTITUENTS.	Hobart Rivulet, mean of three samples.	Cove-water 13 yards from mouth of Rivulet.	Cove-water 100 yards from mouth of Rivulet.	Cove-water 150 yards from end of Elizabeth-st. pier.	Derwent water in mid-channel.	Ordinary sea-water.	Mean of samples of sewage from water-closet towns.
Total nitrogen in solution ..	0·61	0·20	0·06	0·02	0·015	—	5·41
Chlorine in chlorides ,,	18·90	581·00	1029·00	1127·00	1127·00	1365·00	7·46
Total solids in solution ...	62·33	1359·00	1948·00	2144·00	2151·00	2468·00	50·54
Organic matter in suspension	8·10	1·00	0·40	0·50	0·60	—	14·36
Mineral matter in suspension	11·33	1·80	0·90	0·90	1·10	—	16·93

These figures, taken in connection with the relative volumes of the dry weather discharges from the Hobart Rivulet and the proposed Macquarie Point outfall, give the following results, the first column showing the daily quantity discharged from the Hobart Rivulet into the Cove, and the second column that proposed to be discharged from Macquarie Point into the tideway:—

Of nitrogen in all forms in solution	195lb.	692lb.
Of chlorine in chlorides	6,048lb.	947lb.
Of all matters in solution..	19,945lb.	6,418lb.
Of organic matter in suspension..	2,592lb.	1,823lb.
Of mineral matter in suspension..	3,625lb.	2,150lb.
Of all solid matters in solution and suspension..	26,162lb.	10,391lb.

It will be noticed that the only matter that is greater in quantity at the Macquarie Point outlet than at the Hobart Rivulet is the nitrogen in solution. If the discharge were into a small basin of drinking water, this matter would be of importance; but as it is into a large basin of salt water, it is of none, for it is in solution, and cannot pollute the shores of Sandy Bay, nor any other shore. But all other matters are in excess at the Rivulet—the total quantity of solid matter discharged there being two and a-half times as much as that proposed to be discharged at the Point. And it must always be borne in mind that the larger quantity is discharged into comparatively stagnant land-locked water, while the much smaller quantity is proposed to be discharged into running water, that is, the larger quantity is discharged where its polluting effect is certain to be the most marked and constant, and the smaller quantity where its polluting effect is equally certain to be the least, as the purifying effect of the recipient water will be the greatest. The purifying effect of water is due to the action of the oxygen it contains. Mr. William Odling, the celebrated chemist, in his evidence given last November before the Royal Commission on the water supply of London, said—"Four tons weight of oxygen is contained in every hundred million gallons of water (1 ton in 112,000 tons); oxygen had power to destroy 4·5ths of its weight of organic matter. This oxydisation is not a mere theory, but is based on solid fact." Of course, in order that this oxydisation may be effected it is necessary that the organic matter should be exposed to the action of the oxygen in the water—should, in fact, be brought into contact with it. This can only be secured by continual movement of the water, hence the well-known purifying effects of running streams.

Bearing all this in mind, it will be useful to note what is the effect of the daily discharge of the 26,000lb. of solid matter from the Hobart Rivulet into Sullivan's Cove. This effect can be noted in the analysis above given only in the constituents that are absent from sea-water, that is, the nitrogen in solution and the matters in suspension, as the immense quantity of salt and other solids in solution in sea water altogether mask the effect of the comparatively feeble additional quantity brought in by the Rivulet. It will be seen that to all practical intent the water of the Cove is as little polluted at 100yds. from the mouth of the Rivulet as it is in mid-stream, where the Rivulet cannot affect it. It is true that there are 4-100th parts of a grain more nitrogen to the gallon of water, but there 20-100th parts of a grain less organic matter in suspension. At 450yds. from the mouth of the Rivulet all trace of the effect of its discharge may be said to be lost, as the slight difference in the quantities of their constituents, when the water of the Cove there and that of mid-stream are compared, is attributable rather to the Kelly steps and Timber Wharf sewers than to the Hobart Rivulet.

The question to be answered is thus shown to be:—"If the discharge of 26,000lb. a day of solid matter into the comparatively still water of Sullivan's Cove has virtually no appreciable effect upon it, what will be the effect upon it of the discharge of 10,400lb a day into the tideway, 600 yards further away?" And we are asked to answer it, though we have proved the contrary, "that the effect will be disastrous." Can the force of unreason go further? Perhaps it can; and in the nature of the proofs that are given of what will be the consequence of discharging sewage at Macquarie Point. To say nothing of Sydney sewage being traced across 1,000 miles of Pacific rollers to the coast of New Zealand, it is said that the fact that the Hobart Rivulet, when in flood on the 18th of January this year, discoloured the waters of the Cove, showed what the effect would be of the proposed discharge of sewage at Macquarie Point. Now I gauged the water of the rivulet on that day, and found that very nearly 1,600,000 tons of water were flowing under Campbell-street bridge in the day—about 160 times the dry weather flow, and 400 times the estimated discharge from Macquarie Point. At the lowest estimate I could make without analysis, this water contained three times its usual quantity of earthy matter; that is, about

1,700,000lb. of mineral matter in suspension were sent into the Cove instead of the usual 6,000lb. of solid, and as compared with the 4,000lb. a day of the Macquarie Point discharge. Yet we are gravely told that the discharge of these 4,000lb. a day into the tideway outside the Cove would have the same effect as the discharge of 1,700,000lb. into the still water within it.

One other point is elucidated by the analyses. The quantity of salt in the mid-stream sample of the water as compared with that in sea-water, shows that the Derwent water was at the time and place ordinary sea-water diluted with 21 per cent. of river water—a fact that agrees with the estimates of the great daily downward flow of the fresh water.

DISCUSSION.

Mr. Rule said Mr. Mault had given nothing to show that the smaller quantity of nitrogen found at a distance from the rivulet was due altogether to the greater mass of water; it might be due to evaporation. He emphasised Major-General Tottenham's argument that the decrease of organic matter might be due to sediment, and agreed with him as to the tidal courses.

Dr. Bright said that what was thrown ashore at Sandy Bay and other points might come from ships in harbour. People quite overlooked the fact that this drainage scheme was to improve the condition of the city from a health point of view. As a matter of fact, the health of the city was getting worse in preventible diseases. From 30 years' experience on the hospital medical staff, he could testify that the actual result of the atrocious pan system, misnamed the sanitary system of Hobart, was to increase the number of typhoid cases. Typhoid could be contracted by smelling as well as drinking. He agreed with every word of Mr. Mault's paper.

Mr. R. S. Milles, City Surveyor, thought the discharge into the tide-way would not affect the health of the city. The chief cause of the present trouble along the shore came from the lighter matter always found in streets of cities, and brought down by flood waters. A separate system entirely would be impracticable at present, because, to his mind, there would be always a certain amount of expense entailed by repairs and maintenance of the present system of drainage; in addition to a cost of from £10 to £15 a house for connecting with the new system.

Dr. Crouch approved of Mr. Mault's paper. The question was one of expense. If Mr. Mault had his choice of the three schemes submitted to the Metropolitan Drainage Board, that adopted at Southampton, the city more nearly approaching Hobart, would cause no ill effects to the Derwent.

Mr. F. M. Young thought a mudbank might result at the outflow and be a nuisance to boats, but with that single exception there was nothing to be afraid of in the proposed system.

Alderman G. S. Seabrook asked whether the scheme was to be a deep drainage system or otherwise, and for information as to the outlet to midstream. It would be manifestly unfair to ask the citizens to alter their present drainage and to repeat the operation a little later. His experience made him afraid that unless the drainage were carried right out into mid-stream it would find its way on shore. The suggestion for a destructor was worth consideration, and if the slaughter-houses were not removed he hoped one would be obtained and all refuse destroyed. Anything to remedy the present evils would receive his support either in the Council or elsewhere.

Mr. **Mault**, in reply, said he proposed to burn the screenings, but that question was very much smaller than supposed. The daily volume of screenings of the sewage from 3,000,000 of people he had stood by and seen to be small enough to place on the table before him. And he hoped they would be burned in a destructor, which he did not think would be a costly affair. If anything were making the Corporation hold its hand it was the possibility of an arrangement being come to for a joint use of a destructor by the Metropolitan Drainage Board and the Corporation. Undoubtedly, whatever insoluble matter was brought down into the river must sink to the bottom sooner or later. But he had shown that if the volume of insoluble matter discharged were three times what it would be it would take 100 years to form a deposit 1in. thick over the bottom of Sullivan's Cove. It would cost £100,000 to take a sewer into mid-stream. The sewage would be discharged into deep water, and there would be no danger of a mud bank forming. There would be no difficulty, as anticipated by Mr. Milles, in the definition of public and private sewers. Nor did he anticipate, unless circumstances were very different to what they were in towns of a similar size in England, that the cost of connection would be anything like £10 a house. He thanked the meeting for the patient hearing accorded him.

Sir **Lambert Dobson**, in moving a vote of thanks to Mr. Mault, said one little matter should not be overlooked. When the pan system was started no provision was made for emptying the pans. Before a drainage system was adopted there must be a water supply, otherwise the difficulty would be repeated. Therefore the public would be in the hands of the Corporation, and could not have proper drainage till a better water supply was provided. He quoted the opinion of a gentleman holding a high sanitary degree in England to the effect that the greatest danger to health was from the slops from houses.

The vote of thanks was unanimously passed to Mr. Mault, who acknowledged it.

NOTES ON THE MOUNT LYELL MINE.

By E. D. Peters, Jun., M.E., M.D.

The western coast of Tasmania possesses but few indentations that can serve as reasonable harbours. Of these the most important one, commercially speaking, is Macquarie Harbour, on which is situated the port of Strahan. The country north of Strahan was subject to enormous fluctuations of level during early Silurian days, and deep seas alternated with wide, but shallow, lagoons, which in time rose into rugged hills, only again to disappear beneath the waters and lose their identity under the mud and pebbles that filled up the depressions and levelled the sea floor as with a smoothing iron. The mud and silt brought down by the ancient rivers, hardened into clay, slate, and schist, the pebbles were cemented into the ubiquitous conglomerate; the blanketed sea floor, unable to lose its heat by radiation, sank deeper and deeper, causing the crumpling and upheaving that led to the last cycle of mountain-building, and the general configuration of the country became perhaps something as we now see it, though no doubt much lowered and scored, as well as filled up, by erosion and glacial action. Let us for a moment go back to a period just before this last upheaval, and imagine a shoal pond or series of ponds nearly filled with the pebbles brought into it by the foaming rivers of that period, and undergoing, in common with the region surrounding it, a slow subsidence, say something like the coast of Norway at present, which I believe amounts to a considerable number of inches in a century. Owing to causes that we have no time to consider, the roaring mountain torrents were diverted or suppressed, and were replaced by more sluggish and feebler streams, that flowed through extensive bands of a schist rock before entering our chain of ponds. This belt of schist contained then, as it does still, specks of sulphides of iron and copper—pyrites—scattered through it, and although the amount of these sulphides in a single cubic yard of the rock was very small, yet their aggregate in even a single quarter of a mile of the belt was enormous, as can easily be determined at the present day. Pyrites, under these conditions, decomposes very rapidly, and forms soluble sulphates of iron and copper, whilst a considerable proportion of any silver that may be present is also dissolved by the waters of the stream. Even gold will go into solution to a minute extent, especially if the waters of the stream contain a little chlorine. This extremely dilute "mineral water" enters our pond, or ponds, through many different little trickling rills, and we can easily imagine the flow to be so slow, and the evaporation from the extensive surface of shoal water to be so great, that the solution is perceptibly concentrated in its sluggish passage toward the outlet of the chain of lagoons. The evaporation might even equal the supply, in which case we should have a "great salt lake," with a decided admixture of the metals referred to above. But there are no evidences to warrant any such conclusion, whilst there are strong grounds for believing that the amount of salt in the water was not only very small, but that the lakes had an outlet. But a new element must now be introduced, without which I fear that the wealth now locked up safely in the Mount Lyell mine would have quietly flowed out of the ponds exactly as it went into them, and eventually have gone to augment the metallic contents of the oceans. In most parts of the world, though apparently very rarely in Australia or Tasmania, nearly any local geologist could point out to you a swamp or peat bog into which streams discharge that have percolated through slate or schistose rocks carrying pyrites. If you watch carefully at the point where the sluggish, acrid waters of the stream begin to mingle with the black, peaty liquor of the bog, you will find fresh bright crystals or nodules of iron pyrites. Select a blade of grass or stem of a plant that has a little bunch of these crystals hanging to it, and after counting them and drawing an exact sketch of them in your notebook, return in a month and investigate again. If the conditions are favourable, you will not only find many new crystals, but a great augmentation in size of the original ones. This is without question the key to the formation of Mount Lyell and all similar pyrites deposits, and it is almost universally accepted as such by those who have given the subject attention. I myself feel no doubt in the matter. Organic, peaty acids have this power of reducing soluble sulphates of certain metals to insoluble sulphides, and precipitating them *in situ*. If it is done very slowly, the metals will be thrown down in a more or less crystalline form. If rapidly, in an amorphous and massive form. The subsidence of the land, and the consequent filling up of the ponds with sulphides, continued through many hundreds or thousands of centuries. But at last came a time when the elevation of a ridge, or some change in the configuration of the country, the supply of metallic waters was cut off from our pond-holes, or, more probably, lost in the inundation of muddy waters that blanketed all this region with a thick layer of hydro-mica-schist, and the sulphides disappeared from view, to undergo, under its heavy covering of mud rocks, the changes and metamorphoses that time and heat are sure to bring about. Successive layers of pebbles, of sand and of other *debris* buried our hydro-mica belt, till at last came the final act in the great drama, and the stage was set for the last act, the period which we now see. This last shifting was, perhaps, the most striking and dramatic of any of the various scenes that I have endeavoured to portray, and furnishes us with many interesting and obvious details, that if I could only dwell upon would tend greatly to prove the correctness of the theory here advanced, as well as to explain many interesting, and apparently difficult, details that we now notice in the deposit. This was the last period of mountain building, in which the present great elevations were reared, and the strata between them were dislocated and set on edge. Wherever a break happened to come across one of our bog-hole deposits of sulphides we are enabled to find and utilise them. But the chances are infinitely against such a piece of good fortune, and no doubt dozens of such pyrites masses are buried unsuspected under the rocks that we daily walk over in the vicinity of Lyell, some of them hundreds of thousands of feet from daylight, and others, quite possibly, within a few feet of our unsuspicious boot soles. I can only compare it to a flat cake, containing a very few plums scattered through its interior. Let us break this cake across in two or three places, and set the fragments up on edge in a plate. Out of the dozen or more plums that our supposititious cake may contain, we may, perhaps, bring one or two to light, and in the same way nature and accident have opened to us such deposits as those under consideration. Many other deposits, equally good or better, may exist in close proximity to the single one or two that happen to be brought to the surface by the breaking and tilting of the strata, but nothing betrays their presence, and unless we find them by deep boring, or by running prospecting tunnels at a venture, their wealth will remain wasted to us. Let us assume, therefore, that the strata have been broken across in such a manner that the line of fracture comes across one end of our bog-hole, now filled with pyrites, and deeply covered by other strata of rocks. Let us further assume that the fractured strata are next tilted so that the exposed end of the sulphide body comes to the surface, and the whole mass of pyrites, instead of lying in its original horizontal position, is now standing on edge, so that what was originally its depth is now its thickness, and what was once its lateral extent is now its depth. This is the present condition of the Mount Lyell mine, and, bearing this in mind, it is possible to form some slight opinion as to its probable extent in depth. Take any ordinary lagoon, or shallow swamp-hole, and we may say in a general way that its length or breadth is many times its depth. An ordinary shoal pond of this kind might be perhaps 10ft. deep, and certainly 500ft. to 5,000ft. in length. And if it were 100ft. deep we should expect its length and breadth to be very considerable. But the Mount Lyell mine had an original depth—present width—of over 300ft., so that we may reasonably expect that it will continue in depth—former horizontal extent—to a distance far beyond our powers of penetration. The experience of such mines all over the world bears out these theories to perfection, and I cannot, at present, recollect a single large body of pyrites that has "played out" in depth. The 200ft. tunnel in the Mount Lyell mine shows that at this depth the deposit is thicker than at the surface—a plain indication that we are as yet working at or near to its upper edge, for it is likely to go on increasing gradually in thickness until the centre of the former swamp-hole is reached, after which it will gradually grow thinner, as the pond shoaled towards its farther bank. The filling of an ordinary pond will usually give us a more or less lens-shaped body, and it is a notable fact that this is so commonly the shape of these deposits that they are often called "pyritic lenses." While this great body of sulphides was deeply entombed under hundreds of feet of more recently formed facts, it is probable that but few changes occurred within itself, as air and water, the two great agents of decomposition, were practically absent. But as soon as one edge of the deposit was raised to the surface, the unceasing action of these powerful agents began, never to entirely cease until every particle of sulphides in the entire deposit have been modified up to their highest possible pitch of oxidation and hydration. In the case of iron pyrites this final stage is a hydrated oxide of iron, or frequently a hematite. The copper of the pyrites, being easily changed into a soluble sulphate, is soon dissolved and carried away by water. With these facts in mind, let us examine the present upturned edge of the deposit at some point where it has not been covered by gravel and *debris* rolling upon it from the hill above it, and see how actual results correspond with our theories as to what *ought* to take place. Here we find, just as we should expect, an immense mass of oxide of iron, partly hydrated and partly non-hydrated. It contains no copper—copper as I have explained being so extremely soluble that it quickly disappears in a wet climate—the silver veins, is, on the whole, increased. The latter phenomenon may seem peculiar at first sight, but it is strictly as we should expect from our knowledge of the properties of this metal. Gold is almost insoluble, whilst copper is extremely, and iron slightly, soluble, as sulphates, and the sulphur itself all disappears by oxidation or solution. Hence from the mere change of the sulphides into an oxide, we have a decided diminution in weight, and a consequent concentration of the gold. But a still more potent agent assists the enrichment of this surface ore, or gossan, in gold, especially very close to the surface. This is the removal of oxide of iron mechanically in minute particles, either as a dry dust, by the wind, or more deeply by the trickling of drops of water through the easily permeable gossan, and the mechanical removal of particles of oxide of iron as fine scum, to be deposited, perhaps, a few feet further on, as a bed of iron-ochre or iron-sinter, entirely free from gold. Plenty of such material is found near the surface of this and similar deposits. Thus certain portions of the gossan lose all their copper and sulphur, and much of their iron, and having lost 2-3rds to 5-8ths, or perhaps even 19-20ths of these elements, become correspondingly richer in gold. The accuracy of this explanation is very curiously and beautifully attested by the presence of a substance that I have not yet mentioned, but that exists in the Mount Lyell mine ore to an extent so minute, to be sure, that only chemical analysis assures us of its presence, but that yet does exist in every pound of sulphides in the entire deposit. This is the well-known mineral heavy spar, or sulphate of baryta, a common enough gangue-rock in many regions, and one that is always dreaded from its stubborn and infusible character. In the average ore of the Mount Lyell mine there is too little heavy spar to have any perceptible effect upon the metallurgical treatment of the ore. This mineral is absolutely insoluble and undecomposable under any ordinary conditions, and thus during the oxidation and removal of the sulphur, copper, and part of the iron, the heavy spar remains behind together with the gold and the rest of the iron. If you will take the trouble to examine an average sample of the Mount Lyell gossan, you will find that instead of containing, as does the ore, about 2 per cent. of heavy spar, this mineral has risen to 30, 40, or even 50 per cent., whilst the iron has diminished accordingly, and the gold has increased from 3dwt. to 20dwt., 30dwt., 40dwt. or more. Surely no prettier harmony between theory and fact could be asked for. There is little more to be said about the rest of the deposit. As already explained, it is a great lens-shaped mass of mixed iron and copper pyrites set slantingly on edge, with its upper edge slightly decomposed on the extreme surfaces. Its average width may be regarded as 300ft., while it has been followed for about 1,000ft. in length, and about 300ft. in depth, at which point it is gradually widening. After getting a few feet from the wall-rock, and fairly into the deposit, the pyrites is so pure and massive, that in four months' residence at the mine I never saw a fragment of gangue rock as large as a cherry. The average composition of the unaltered ore is about as follows:—

Iron pyrites	83 per cent.
Copper pyrites	14 „
Heavy spar	2 „
Silica	1 „
Total	100

And the average contents of the ore in the valuable metals, throwing off enough to cover ordinary losses, is

Copper	4½ to 5 per cent.
Silver	3 to 4oz.
Gold	2½ to 3dwt.

Although the ore is simply an ideal sulphur ore for the manufacture of sulphuric acid, not only containing 50 per cent. of sulphur, but also being an almost perfect burning ore mechanically speaking, the company will be obliged to forego this advantage for the present. For the new process for making soda has so injured the acid market that pyrites ores are simply a drug, even if it would pay to transport the Lyell ores to the coast, and thence to England. To make acid on the spot can of course not even be considered, as there is no market for it at home, and the cost of the very lowest freight to a market would be about twice and one half the value of the best acid. I need hardly say that the treatment must necessarily be the amplified form of the old blast-furnace method, *i.e.*, roasting in stalls under cover, smelting the roasted ore for a matte containing the copper, silver and gold, blowing this matte up to a 96 per cent. pig-copper in Bessemer converters, shipping the pig-copper to England, where the gold and silver will be separated by electrolysis, which consists in dissolving the pigs of copper in weak sulphuric acid at one pole of the battery, whilst chemically pure copper is re-deposited at the other pole, and the gold and silver fall to the bottom of the tank as mud. To institute a business commensurate in importance to the site of the deposit, and the magnitude of the entire scheme, 1,000 tons of ore daily should be treated, yielding, say—

50 tons copper, worth £44 per ton	£2,200
3,000oz. silver, worth 2s. 6d. per oz.	375
3,000dwt. gold, worth 4s. per dwt	600
Making a daily output of	£3,175

This paper is not intended to touch at all upon the commercial aspect of the mine, and I only mention these few facts, that have already been made public in my report, for the satisfaction of those who cannot understand how such low grade ores can be made to pay. I cannot possibly go into details of cost or treatment of the ore, but to furnish a clue to those who may desire to make their own calculations, I will state that the one important item of cost in the entire treatment is the cost of smelting the ore. The mining will be done by open quarrying for 20 years. The stall-roasting of similar ore has not cost me 1s. per ton any time in the past 16 years—reduced to Tasmanian wages and conditions. The bessemerising and remaining operations come solely on the matter, so that they are reduced to a very small sum for each ton of ore, but the smelting comes on the original roasted ore, and is always the heavy expense. A modern water jacket will put through 100 tons of ore daily, per 24 hours, will require five men per shift, and 1 ton of coke to each 7 or 8 tons of ore. As the company possesses a water power far beyond the needs of all its machinery, very little need be added for blast. From these rough statements it will be seen that even the smelting cost need not be very alarming, when executed on this large scale. To return to our proper subject. There is yet one point more that I have to speak of, and it is in this point that the Lyell mine is unique. In all points—except its unusual richness and width—it is almost precisely like scores and hundreds of similar pyrites deposits in other parts of the world. All have the same decomposed gossan on top, except where glacial or other causes have scored them clean. All are richer in gold above than in pyrites below, and all that contain gold invariably run into pyrites in depth. All, or nearly all, have the same sinter and iron-ochre amongst the gossan in places that makes inexperienced people regard them as geysers or hot springs, when in reality this phenomenon is simply a secondary metamorphosis of the gossan. I have even been told that some geologists have pronounced these characteristically aqueous deposits as volcanic, and the heavy spar a result of sublimation. But I am not willing to believe this, for surely every geologist knows that heavy spar is one of the few substances that are absolutely non-sublimable, and can only be formed by aqueous solutions, whilst iron pyrites is bi-sulphide; that even if there were no air present to roast it, would at once lose one atom of sulphur on the slightest approach of heat, and become a mono-sulphid magnetic-pyrites, whilst the sublimed sulphur would be deposited in the crevices of the rocks. But it is as idle at the present day to argue in favour of the deposition of these deposits by the means I have described, as to waste time in trying to prove that the earth moves around the sun. Everybody who is familiar with these deposits—and they are amongst the most common in many countries—is agreed as to their method of formation, and instead of their being unique, as I have heard one or two people call them, Mount Lyell and Mount Morgan, and similar deposits are the commonest and best known class of mines that we have. The infinitesimal extra percentage of gold that they happen to contain gives them an enormous commercial interest, but, geologically-speaking, they are almost too common and their mode of formation too well understood to be interesting. Where their wall rocks contain much felspar there are sure to result great beds of kaolin from the action of the decomposing sulphides upon the same. I have never seen or read a description of Mount Morgan, but after hearing of the rich gold in hematite and beds of kaolin I am as certain of the existence of pyrites below as though I had seen it uncovered. Either of these two points prove the existence of sulphides below. The single unique feature that Mount Lyell can show is the existence of a very extensive mass of very solid oxide of iron, containing about as much gold as the pyrites, but free from silver or copper. As it is evident that this ferruginous mass was derived in some manner from the pyrites it becomes interesting to learn what can have become of the large amounts of copper and silver that belong to this mass of half-a-million tons or more of iron. Recent explorations at a depth of 250ft. seem to have solved this question. For at this point, on getting under one corner of the mass of iron-stone on the foot-wall of the deposit, a series of shoots of argentiferous copper pyrites have been discovered and worked, that are, I think, unparalleled for their richness in the history of these low grade ores. The massive copper pyrites is sometimes 6ft. or more in width, and not only carries some 600oz. to 800oz. silver per ton, but is filled with grains, nodules, and masses of pure sulphide of silver—87 per cent. silver—sometimes as large as a cocoanut, and increasing the bulk value of the ore to something like 2,000oz. per ton. Over 100 tons of this ore have already been mined and shipped, and we have every reason to believe that we are only on the edge of the deposit. I mention this peculiar feature of the Mount Lyell mine more to explain how it is that a deposit consisting of such low grade ore as I have been describing can ship such extraordinarily rich material as the Mount Lyell is known to be now doing, than because it has any bearing on the "genesis" of the deposit itself. As you see, this rich ore is quite a secondary affair, and has no bearing on my subject. This completes all that I have to say in this brief paper. I must apologise for its fragmentary and unsatisfactory form. But I have been forced to write at sea, and in the intervals of more serious labours. I can hardly imagine a more interesting subject for an enthusiastic student of the natural sciences to investigate than this very Mount Lyell mine, for there are many minor, though extremely interesting and important, points yet to be investigated that I have not even touched upon.

SOME ADDITIONS TO THE MOSS FLORA OF TASMANIA.

By W. A. Weymouth.

This paper will deal (1) with Tasmanian mosses new to science; (2) with known species now first recorded for Tasmania; and (3) with a few already recorded for this colony, but either rare or not previously described.

The determinations are by European scientists. One of these, Dr. O. Burchard, of Hamburg, has reported 65 new species, a list of which was received from him by the Secretary of this Society in January, 1892. None of these determinations having, up to date, been supported by descriptions for publication, I have hitherto refrained from calling your attention to them. Only a few that have been revised and confirmed by another authority are included in this paper.

Professor V. F. Brotherus, of Helsingfors, who has for some years been engaged upon the mosses of Australia, and more recently upon those of Tasmania also, has just published in Part II. of "Some New Species of Australian Mosses described by V. F. Brotherus" original descriptions of six new species from this colony. My versions of these descriptions are given below. Following them are other new species, for which descriptions will be forthcoming later on.

One of our most interesting mosses is *Pleurophascum grandiglobum*, Lindberg, which up to the present has been recorded only as collected by Mr. R. M. Johnston, near the Picton River. I can now add that it has been obtained by Mr. Wm. V. Fitzgerald in the neighbourhood of the Little Henty; by Mr. T. B. Moore on the highlands of Mount Tyndal; and by the Rev. John Bufton, F.L.S., at Port Davey. Mr. Johnston's specimens passed to Professor Lindberg very many years ago through the hands of Baron von Müeller, who also furnished Messrs. Moore and Bufton with the name.

I would call the attention of the Fellows present to the mounted examples on the table; and would especially mention that Mr. L. Rodway, to whom I am indebted for ever ready help with microscope and pencil, has kindly undertaken to illustrate some species by drawings of their several parts.

MOSSES NEW TO SCIENCE.

1. *Ulota Weymouthi*, Burchard, n. sp.

Hab.—On wood, Falls Track, Mount Wellington, W. A. Weymouth, No. 615.

2. *Ulota cochleata*, Vent., n. sp.

Monoicous. In small, dense cushions, depressed, yellow-green. Stem creeping; branches erect, 1 cm. high. Leaves curled when dry, erecto-patent when wet, very dense, 2·10 mm. long, from a red, very concave, discoid-ovate base quickly contracted, linear-narrow-acuminate, acute, margin scarcely recurved below. Areolation above by cells 3—4 micromill. wide, rectangular, with thick, smooth walls; below, towards the base, marginal cells transparent, square; in the middle follow very narrow, fuscoid cells, with very thick walls tinged with red. Nerve thin, extending to the apex. Perichaetial bracts larger, 3·5 mm., from a dilated reddish-brown base long lineal-lanceolate, with a flat margin. Male gemmulæ lateral, reddish-brown; antheridia numerous, 34 micromill. long, shortly stalked, linear. Vaginula bare, ovate, with short ochrea. Seta 3·5 mm. long. Capsule with short neck, oval, 1·5 mm. long. Operculum conic, with a short beak. Peristome of 8 reddish-brown teeth, reflexed when dry, 30 micromill. long, in double pairs, long acuminate, single thread-like legs, attentuate, perforate from anastomosing joints, densely and very minutely papillose. Cilia 8, thread-like, shorter, transparent. Stomata emersed, arranged in middle of capsule. Striæ 8, consisting of 3—4 series of wide cells tinged with yellow, running the whole length of the sporangium; the rest of the epicarpic cells quadrangular, very small, with walls by no means incrassate. Annulus very narrow, persistent. Calyptra yellow, bell-shaped-conic, brunescent at apex, densely pilose, strigose, divided at the base. Spores minutely papillose, 30—35 micromill. in diameter.

Hab. Mount Wellington, on trees, 1891, W. A. Weymouth, No. 898.

3. *Ulota anceps*, Vent., n. sp.

Monoicous. In small, dense cushions, green. Leaves scarcely curved when dry, erecto-patent, 1·5 mm. long, from a yellowish ovate and concave base gradually narrow, linear-lanceolate, acute, margin recurved below; nerve thin, vanishing in the apex. Upper cells 7 micromill. wide, round-ovate, walls not very incrassate, papillæ short, thick, prominent; lower cells longer, narrower, quadrangular; the marginal series, however, shorter, quadrate; all yellowish except the lowest, which are reddish. Perichaetial bracts up to 2·25 mm., from a rather long red base gradually linear-acuminate. Male gemmulæ lateral, reddish; antheridia 31 micromill. long. Vaginula with simple yellow hairs, oval, ochreate. Seta 3·5 mm. long. Capsule with short neck, up to 2·5 mm. long, ovate-elongate, furrowed for the whole length when dry. Striæ 8, furnished with a double series of cells. Stomata emersed, arranged in lower part of sporangium.

Annulus simple, persistent. Teeth 8, closely reflexed when dry, in double pairs, 24 micromill. long, obtuse, apex not free, not lacunose but sparingly perforate, joints dense, short, and very minutely papillose. Cilia 8, of equal length, thread-like, smooth. Calyptra yellow, strigose, densely pilose, the hairs being thick, rather rough, and of 4—5 series of cells. Spores minuutely papillose, 30—35 micromill. in diameter.

Hab. Mount Wellington, on trees, 1891, W. A. Weymouth, No. 900.

4. *Ulota viridis*, Vent., n. sp.

Monoicous. Tufts depressed, green; stem creeping; branches scarcely 1 cm. high, erect. Leaves scarcely curved when dry, from an ovate concave base gradually linear-acuminate, acute, 1·5 mm. long. Areolation above by gently projecting cells, without papillæ; below at margin with 7—9 series of transparent and quadrate cells, forming a border; the middle part consisting of narrow, fuscoid cells, with very broad walls tinged with red. Perichætial bracts from a rather long base red, larger, 2 mm. long. Vaginula sparingly pilose, ovate. Seta 1·5—1·75 mm. long. Capsule pyriform, with tapering neck of equal length, 2 mm. long; when dry furrowed to the middle and beyond. Striæ short, scarcely a third of the sporangium long, consisting of 2—3 series of cells. Stomata emersed, dispersed in the neck. Teeth 8, reflexed when dry, in double pairs, apex entire and obtuse, minutely papillose, jointed. Cilia 8, of equal length, threadlike, smooth. Spores minutely papillose-aculeate, 23—25 micromill. in diameter. Calyptra conic-bell-shaped, scarcely covering half the capsule, divided at the base, pilose with yellow hairs consisting of two, rarely three, series of cells.

Hab.—Mount Wellington, on trees, Oct., 1890, W. A. Weymouth, No. 901.

This plant is very near to *U. Ludwigii.*

5. *Orthotrichum lateciliatum*, Vent., n. sp.

Monoicous. In tumescent tufts; stems erect, 2 cm. high. Leaves curved and laxly crisp when dry, erecto-patent when wet, from an ovate base long lanceolate, keeled, 3·33 mm. long, apex more or less acuminate, margin recurved up to apex, nerve lost in apex. Areolation above by round hexagonal cells, walls not incrassate, papillæ prominent, simple or two-pronged; below elongated, narrow cells, with walls not incrassate, complete the base. Inner perichætial bracts rather small, with flat margin. Inflorescence lateral; male gemmulæ small, antheridia few, ovate-oblong, stalked, without paraphyses. Vaginula cylindric, sparingly pilose, with a distinct ochrea adhering to the seta. Seta 3·20 mm. long, twisted when dry. Capsule with short neck, quickly becoming ovate-cylindric, 1·75 mm. long. Striæ extending to the middle of the capsule, composed of 4-5 series of rather wide cells, when dry prominent, furrowing the capsule to the middle. Stomata emersed, in lower part of sporangium. Annulus bi-triseriate, persistent. Peristome of 8 external teeth, red, laxly recurved when dry, in double pairs, entire, obtuse at apex, legs connected, jointed, joints very short, very densely papillose. Cilia 8 shorter, obtuse, papillose, reaching to half or more of the teeth, and having 3-4 joints. Spores 24—26 micromill. in diameter.

Hab.—Mount Wellington, on trees, W. A. Weymouth, No. 895, New Town Rivulet; and No. 897, St. Crispin's.

Akin to *O. Tasmanicum*, Hk. *f.* Wils., but more than sufficiently distinguished by its much greater size and distinct striæ, and other marks.

6. *Mniobryum Tasmanicum*, Broth., n. sp.

Dioicous; cæspitose. In tall, soft, pale, glaucous-green, somewhat loose tufts, not shining. Stems up to 8 cm. high, erect, flexuous, red, the lower part with fuscous radicles; branching by slender, laxly leaved innovations up to 3 cm. long. Leaves of the stem patent, of the innovations patulous; all nearly equal, shortly decurrent, linear-lanceolate, somewhat flat, acuminate, acute, about 3 mm. long and 0·47-0·53 mm. wide, margin erect everywhere, from middle to apex acutely serrulate, not bordered; nerve thin, about 0·05 mm. wide at the base, vanishing below the apex; cells elongate, narrow, in middle of leaf 0·175-0·225 mm. long and 0·015 mm. wide, all nearly equal, thin-coated, very smooth. The rest unknown.

Hab.—On the wet banks of streams, Mount Wellington, W. A. Weymouth, No. 1,151 Falls Track; No. 1,153 St. Crispin's; and No. 1,154 New Town Falls.

Near *Mn. albicanti* (Wahlenb.), Limpr., but differing specially in the narrower and narrowly acuminate leaves, acutely serrulate from middle to apex, and likewise in the much longer and narrower cells, pointed at the ends.

7. *Cyathophorum densirete*, Broth., n. sp.

Dioicous; slender, green or pale-yellow-green, shining. Stem creeping, covered with dense reddish-fuscous tomentum; stipites sparse, erect, slender, flexuous, apex more or less attenuate, simple, black, densely leafy. Leaves scarcely altered when dry, patulous when wet, irregular in outline, base ventricose at the upper side, ovate, acute, margin erect, coarsely and acutely serrate from middle to apex; nerve very short, rather broad, forked; cells rhomboid, firm and resisting, the upper 0·045—0·06 mm. long and 0·015—0·020 mm. wide, margin narrow, forming an indistinct border. Amphigastria much smaller, symmetrical, round, with straight, very acute point, nerve obsolete. Perichaetial bracts from a sheathing base suddenly narrow, acute, apex sparingly but coarsely serrate. The rest as in *C. pteridioides*, Beauv.

Hab.—South Road Forest, Circular Head, on trunks of trees, April, 1892, W. A. Weymouth, No. 862. [New Town Falls, June, 1893, L. Rodway.]

Differs from *C. pteridioides* in its much smaller size, much denser areolation, and very short nerve.

8. *Isopterygium acuminatum*, Boswell, n. sp.

Hab.—On face of rocks, Bridge Gully, Glen Rae, Sorell, and on tree, Zeehan Railway, West Coast, 1891, W. A. Weymouth, Nos. 555 and 630. Mount Arthur, January 1887, D. Sullivan, ex herb. Melbourne, 30.

It is interesting to note that whilst this specimen was founded by Mr. Boswell on my No. 555, Mr. D. Sullivan's specimen, which I received recently from Professor Brotherus, takes priority in date.—W.A.W.

9. *Stereodon flagellirameus*, Burch. Broth., n. sp.

Hab.—On wood, Lymington, Port Cygnet, 1889, and Hobart Rivulet, 1893, W. A. Weymouth, Nos. 191 and 1288.

10. *Thamnium tenerascens*, Burch., n. sp.

Hab.—On wet rocks, Guy Fawkes Rivulet, 1890, and on wood and rock, South Road Forest, Circular Head, 1892, W. A. Weymouth, Nos. 278, 844-5, and 1,088.

11. *Sphagnum serrulatum*, Warnstorf, n. sp.

Hab.—In ditch, Zeehan Railway, West Coast, Feb. 1891, W. A. Weymouth, No. 622.

12. *Sphagnum macrocephalum*, Warnst., n. sp.

Hab.—On the ground, Lake Bellinger Track, Zeehan Railway, West Coast, Feb. 1891, W. A. Weymouth, Nos. 623-4.

13. *Sphagnum pseudo-rufescens*, Warnst., n. sp.

Hab.—In bog, top of Mount Wellington, 1888, W. A. Weymouth, Nos. 972-7.

MOSSES NEW TO TASMANIA.*

1. *Anisothecium crispum* (Schreb.), Lindb. Op. c. 26 (1878).

Syn.—*Dicranella Schreberi*, Schimp. Coroll. 13 (1855).

Dioicous; gregarious and tufted, ½—1in. high; yellowish-green. Leaves squarrose, from a dilated semivaginant base, narrowly lanceolate, carinate, irregularly denticulate towards apex, not glossy; areolation firm, narrow, elongated; perichaetial bracts more shortly sheathing. Capsule on a purple seta, cernuous, ovate-oblong with scarce any neck, not striate, exannulate; lid conic, obliquely rostrate, large, purple; peristome purple. Male plant small, simple.—*Dr. Braithwaite's British Moss-Flora,* Vol. I., pp. 113-4, T. XVI. E.

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*[That is, not recorded in Fl. Tasm., in Mitten's list of 1859 (Linn. Jnl. iv.), in Mitten's Australian Mosses, 1882, or in Bastow's Mosses of Tasmania 1886.]

On rocks, New Town Falls, 1889, and St. Crispin's, Mount Wellington, 1890, W. A. Weymouth, Nos. 123 and 519.

2. *Blindia robusta,* Hampe in Linnæa 1860, 627.

On top of Mount Wellington, 1890, W. A. Weymouth, Nos. 481 and 491.

(Also Australian Alps, Victoria, F. v. M., and N. S. Wales and New Zealand.)

3. *Dicranum polysetum,* Hampe.

At Buckland, 1887, W. Turvey (W. A. W. No. 454). Guy Fawkes Rivulet, Russell Falls, and Mount Wellington, W. A. Weymouth, Nos. 455, 456, and 464.

4. *Apalodium lineare* (Tayl.), Mitt.

On damp bank, Beaconsfield, 1892, W. A. Weymouth, No. 1133.

5. *Campylopus pudicus,* Hornsch.

Densely tufted, but only loosely cohering, with a dark-coloured tomentum, ascending, rather rigid, flexuose, rather naked below, subcomose above, interruptedly innovate with filiform, solitary, sub-cuspidate shoots springing out below the perigonium. Stem leaves lanceolate, canaliculate, narrow, produced into a more or less reflexed denticulate hyaline hair-point, above with connivent convolute margins, sparingly rough on the back, almost without cells at the wings; nerve broad, elamellate, base elongate, pellucid, thin, areolation above minutely elliptical. External perichaetial leaves similar to the cauline; internal more or less acuminate, rather broad, slightly denticulate, nerve thin; the innermost broadly convolute, short, coloured, areolation lax, nerve obsolete. Male flower formed of several narrow gemmæ.—*C. Müll. Syn Musc. I.,* p. 407.

Peppermint Bay, 1889, and Guy Fawkes Rivulet, 1890, W. A. Weymouth, Nos. 865 and 296.

(Also found in New South Wales and Queensland.)

6. *Campylopus Tasmanicus,* Schimp.

Peppermint Bay, 1889, McRobie's Gully, and Guy Fawkes Rivulet, 1890, W. A. Weymouth, Nos. 248, 274, and 907.

(Also the Grampians, Victoria, D. Sullivan.)

[Since this paper was read Dr. Brotherus writes:—" *Campylopus tasmanicus,* Schimp., has not yet been described. The large material I received from you has made me doubt whether this species differs at all from *C. introflexus*. . . In any case it is identical with *C. introflexus*, Fl. Tasm."]

7. *Grimmia mutica*, Hampe in Linnæa 1860, 631.

On wet rocks, Mount Faulkner, 1892, and on the Black Rock, Millhouse's Falls, Huon Road, 1893, W. A. Weymouth, Nos. 1,180 and 1,436.

(Also in Victoria, F. v. M., and N.S. Wales, Woolls.)

In Mitten's Australian Catalogue this=G. *apocarpa* var. *foliis muticis*, Fl. Tasm. II., 180.

8. *Tortula muralis* (L.), Hedw. Fund. II. 92 (1782).

Autoicous; densely pulvinate or cæspitant, yellowish or glaucous-green and canescent, sparingly branched. Leaves when dry appressed and twisting, when moist patent, lower oblongo-lanceolate, upper elongate, ligulate, with the apex obtuse, unequally prolonged or subcordate, minutely papillose, the margin yellowish, strongly revolute; nerve yellow, excurrent in a diaphanous hair; upper cells small, chlorophyllose, indistinct, basal rectangular, hyaline. Capsule on a purple or yellow seta, oblongo-subcylindric, pachydermous, regular, dark brown, annulus narrow, subpersistent; calyptra large, pale brown, lid obliquely conico-rostellate; peristome purple, closely convolute, on a very narrow basal membrane. Male inflorescence gemmaceous, on a short lateral branch, bracts ovate, obtuse, mucronate with the nerve.—Braithwaite's *British Moss-Flora*, Vol. I., p. 217.

On stone wall of Garden Crescent Reservoir, Hobart, 1890, W. A. Weymouth, No. 484.

(Also New Zealand.)

9. *Barbula subtorquata*, C. Müll. and Hampe in Linnæa 1853, 492.

On sandy bank, Pirate's Bay, East Coast, 1889, W. A. Weymouth, No. 254 (*a*).

(Also Mount Gambier, South Australia, F. v. M., Australian Mosses, pl. iii.)

10. *Streptopogon crispatus*, Hampe in Linnæa, 1876, p. 304 (under Barbula).

"Nearest to *S. mnioides*; differing in the patent-crisp leaves, the border vanishing at apex, and the immarginate perichætial leaves. On Mount Macedon."

On willow, Johnny's Creek, near Hamilton Road, 1893, W. A. Weymouth, No. 1258.

11. *Tetraplodon Tasmanicus*, Hampe in Linnæa 1876, p. 302.

In neighbourhood of Mount Zeehan, 1892, Wm. Fitzgerald (W.A.W. 785); Mount Darwin, 1893 (alt. 3,400ft.), T. B. Moore.

Strictly speaking this moss is not now newly recorded for Tasmania, for Hampe must have had an original specimen for determination, collected perhaps by Schuster. There is, however, no local record of it; but in Mitten's Australian Catalogue of 1882 *T. Tasmanicus* appears as identical with *Splachnum Gunnii*, H.*f*.W.

A comparison of our specimens with *S. Gunnii* of Gunn's collection in this Museum, made by Mr. L. Rodway and myself, shows that the present moss differs markedly from *S. Gunnii* in its entire instead of dentate leaves, the upper obovate-lanceolate with excurrent nerve, the lower ovoid-acuminate with nerve reaching to apex; in its brown seta; in its capsule, which has a subspherical not an oblate apophysis; and in its teeth, which are reflexed when dry, not erect.

[Since this was read, Hampe's description has reached me, by the courtesy of Dr. Brotherus, and it now follows:— "Densely compact, low, hardly an inch high, base attenuate, blackish, interwoven with tomentum, apex of a roselike crown, short, yellowish-green, densely leaved, simple or developing a short branch. Leaves concave, narrower at the base, obovate-acuminate, entire; nerve yellowish, cuspidate; cells lax, pellucid, the basal elongate, rectangular or parallelogrammic, towards apex of leaf gradually shorter and sub-hexagonal. Seta apical, short, thickened towards its apex into a vesiculose, membranous, ovate apophysis. Capsule small, blackish, attenuate from a broader base, conical, with small mouth; columella persistent; the teeth of the injured peristome short, rather wide, membranous, reflexed. The rest absent. Mount Towers, Lake Pedder, Tasmania. Scarcely to be compared with *T. urceolatus*; in its small, conical, small-mouthed capsule it differs in the widest way from all species."]

12. *Funaria sphærocarpa*, C. Müll.

Very like *F. hygrometrica*. Leaves narrowly oblong-lanceolate, always complicate and crisp; nerve strong, excurrent, running the length of the leaf; cells everywhere elongate and lax, at margin narrower, reticulate; quite entire. Perigonial leaves *entire*. Capsule somewhat larger, *globose both when dry and when wet, without a neck*, lightly sulcate. Australasia, Green Cape, Twofold Bay.—*Bot. Zeit.* 1851, p. 546.

On loamy soil, Queen River Road, Macquarie Harbour, 1891, W. A. Weymouth, No. 644.

(Also found in Queensland.)

13. *Bryum Gambierense*, C. Müll. in Linnæa 1871, 148.

On the ground, Lymington, Port Cygnet, 1889, W. A. Weymouth, No. 242.

(Also on Mount Gambier, South Australia, and the Pyrenees, Victoria, F. v. M. and D. Sullivan.)

14. *Bryum Sullivani*, C. Müll. in Broth. Austral. Mosses II., p. 37.

On wet rocks, Circular Head, W. A. Weymouth, No. 1074.

(Also found in Victoria.)

15. *Bryum cæspiticioides*, C. Müll.

On loamy soil, Queen River Road, Macquarie Harbour, 1891, and Hobart Waterworks, 1892, W. A. Weymouth, Nos. 565 and 838.

16. *Hedwigia microcyathea*, C. Müll. in Bot. Zeit. 1851, 564.

"Very like *H. ciliata*, but the leaves have *angular, elliptical, rather firm cells*, scarcely or not at all crenulate at their walls, those in the middle longer, papillose, and *without chlorophyll, therefore not obscure*. Capsule *minute, hemispherical, cup-shaped, with large mouth*, and *very thick plicate neck*. Rocks below Esk River, near Launceston."

On rocks, Wattle Hill, Sorell, 1891, and the Sugar Loaf, Green Ponds, 1892, W. A. Weymouth, Nos. 714 and 870.

Mitten's Australian Catalogue ties *H. microcyathea*, C.M., with *H. ciliata*, Ehrh., but Professor Brotherus considers the former a good species.

17. *Hedwigidium Campbelliæ*, C. Müll.

On rock, north slope, Mount Nelson, 1890, W. A. Weymouth, 913.

(Also Beaconsfield, Victoria, Miss Campbell.)

18. *Pterygophyllum Levieri*, Geheeb in Revue Bryologique 1881, p. 27.

"Dioicous; stem branched, complanate, pale yellowish; branches obtuse, densely leaved. Leaves complanate, suboblique, immarginate, from a rather narrow base oblong-spathulate, very obtuse, very minutely crenulate along the whole margin; cells prominent; nerve simple, vanishing under the apex, the basal and intermedial cells hexagonal and more or less elongate, the upper much smaller, rounded, incrassate. Perichætial leaves ovate, cuspidate, entire; cells hexagonal, elongate. Capsule deoperculate, oval, fuscous, shining like varnish, erect on a rather short, dark-coloured, shining seta. On Mount Wellington. Like *Pt. complanatum*, Hampe, but the capsule is larger and quite erect; the leaves have very minutely crenulate margins, and the perichætial leaves are entire."

On wet rocks, New Town Rivulet, 1889, and Guy Fawkes Rivulet, 1892, W. A. Weymouth, Nos. 118 and 861.

[Since this list was read, the writer finds *P. Levieri*, Geheeb. included for Tasmania in Baron F. Von Müeller's list in Sup. Frag. Phyt. Australiæ, Vol. XI., p. 113.]

19. *Rhaphidostegium callidioides*, Hampe and C. Müll. in Linnæa 1856, 213.

On wood, Mount Wellington, 1887-8, and Castra Road, Leven, 1892, W. A. Weymouth, Nos. 362, 370, 1,054, and 1,087.

(Also Sealers' Cove, F. v. M.; Australian Mosses, Pl. XIV.)

20. *Raphidostegium calliferum*, Hampe and Geheeb.

Very much like *Hypnum callidioides*, C. Müll., but differing in the subdenticulate cauline leaves and the densely and sharply serrate perichætial leaves. On Mount Wellington (Victoria), Beccari—*Revue Bryologique*, 1881, p. 27.

On wood, Mt. Wellington, W. A. Weymouth, No. 770.

21. *Plagiothecium lamprostachys*, Hampe in Linnæa 1859, 60.

On wood, McRobie's Gully, 1888, W. A. Weymouth, No. 400.

22. *Thuidium sparsum*, Hook and Wils. in Fl. N.Z., II. 109, t. 89, *f.* 5.

Dioicous. Stems very slender, matted, creeping, 1in. long, 2-pinnately branched; branches short, very slender. Leaves dark green, very minute, spreading, incurved when dry, ovate or ovate-cordate, subobtuse, quite entire but rough at the edges; nerve short, pellucid, vanishing below the apex; perichaetial much larger, long acuminate, inner laciniate. Fruit-stalk ½in. long, smooth. Capsule inclined or cernuous, narrow, oblong.—Hooker's *Handbook N.Z. Flora*, p. 481.

Guy Fawkes Rivulet, 1890, W. A. Weymouth, No. 308.

(Also in New Zealand and Queensland.)

23. *Thuidium incompleto-pinnatum*, C. Müll.

St. Crispin's, Mount Wellington, 1888, W. A. Weymouth, No. 339.

Writing on 16th April, 1891, of this moss, Dr. Burchard says:—"It is only found until this time (before you) in New Zealand by Mr. R. Helms. Dr. Müller and I are very glad that you discovered this species in Tasmania."

24. *Fissidens Whiteleggei*, C. Müll.

On stony earth bank, Happy Valley, Mount Bischoff, 1892, W. A. Weymouth, No. 1018 *(a)*.

Mixed with *Mittenia plumula* (Mitt.), Lindb.

(Also in New South Wales and Queensland.)

25. *Fissidens semilimbatus*, Hampe and C. Müll. in Linnæa 1853, p. 501.

"Dioicous, very dwarf, simple. Leaves in 5-6 opposite pairs, the lowest minute, the middle lanceolate, the perichætial slightly cuspidate, concave from a broadly ovate base, apex unequal, margined with a yellow border; the dorsal lamina narrow above the base, not margined; apical lamina lanceolate; nerve yellowish, rather thick, excurrent, not margined; cells everywhere small, hexagonal, chlorophyllose, soft. Capsule on rather long straight seta, red, not much inclined, oblong, minute; operculum rostellate, oblique; teeth of peristome narrow and purple.

"River Yarra.

"Like *F. bryoides*, but distinguished from that by the semi-limbate leaves. From *F. cuspidatus* it is also sufficiently marked off by the structure of its leaves."

On damp sandy bank near Exeter, West Tamar, 1892, W. A. Weymouth, No. 1134.

(Also in Victoria, F.v.M., Australian Mosses, pl. XVIII).

NOT PREVIOUSLY DESCRIBED.

Breutelia commutata, Hampe in Linnæa 1876, 307. (Bastow's list, p. 36, name only.)

Dioicous; robust, vaguely branching, decumbent. Stem nearly everywhere rufous-tomentose; the fertile ascending, radiate above, yellowish, with acute cylindric and tapering branches; the male stem nearly simple, stellate at the apex. Stem leaves accumbent when dry, erect and patulous when wet, from a contracted concave base, many times folded, broadly ovate-lanceolate, nearly quite entire, the nerve extending throughout and ending in a bristly point, the whole margin revolute; the cells shortened parallelograms, the nodules very small and irregularly punctate, the base and side with a slight, rather broad, reflexed covering with squared cells, reticulate, pellucid, enlarged. Leaves of the radial branches smaller, more pellucid, very finely reticulate, markedly rough, with a terete yellowish nerve excurrent in a denticulate awl-like point. The inner perichætial leaves small, ovate-lanceolate, nerved, with a short bristly point, deeply folded, hyaline; cells rectangular, smooth, reticulate. Seta scarcely an inch high, ruddy, apex inclined. Capsule spherical when young, afterwards drooping, oblong, slightly striate when dry; operculum shortly conic, obtuse. Peristome inflexed, very small, blood-red; the outer teeth narrowly lanceolate and acuminate, densely trabeculate; the inner of very short cilia, ovate-acuminate.

The Grampians, W. Sullivan.

Syn.—*Bartramia affinis,* Schwægr. tab. 237, bad; not Hooker, tab. 176.

In Tasmania, in mountainous parts near Lake Pedder, 1875, Schuster, a smaller form, scarcely two inches.—*Linnæa,* 1876, pp. 307-308.

In creek, Lauriston Gully, Kangaroo Point, 1889, W. A. Weymouth, No. 227.

PLATE IV.

Splachnum gunnii, H. et U.

1. Natural size.
2. Capsules.
3. Mouth and peristome (dry).
4. Peristome tooth.
5. Leaf.
6. Areolation.
7. Section.

Splachnum (Petraplodon) tasmanica, Hampe.

1. Natural size.
2. Capsule (dry).
3. Capsule (wet).
4. Peristome teeth.
5. Leaf (upper).
6. " "
7. " (lower).
8. " section.
9. " areolation.

PLATE V.

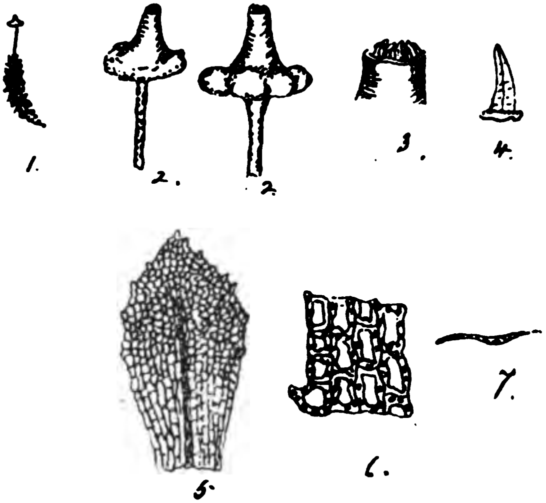
Pleurophascum grandiglobum, Lindb.

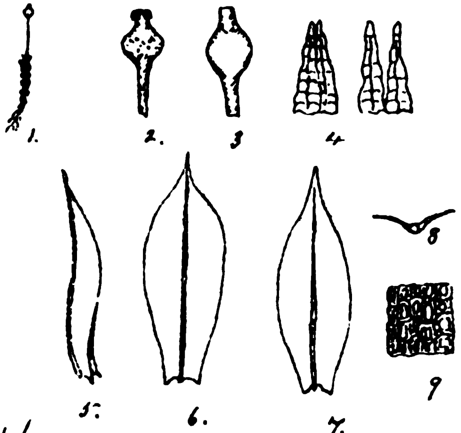
1. Natural size.
2. Capsule and calyptra.
3. Leaf.
4. " section.

Ulota weymouthi, Burch.

1. Natural size, fresh.
2. " " dry.
3. Capsule and operculum.
4. Calyptra.
5. Peristome.
6. " teeth.
7. Leaves, fresh.
8. Leaf, dry.
9. " section.
10. " areolation.

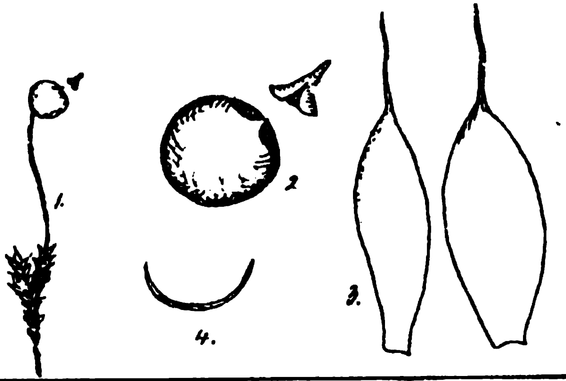
Pl. IV

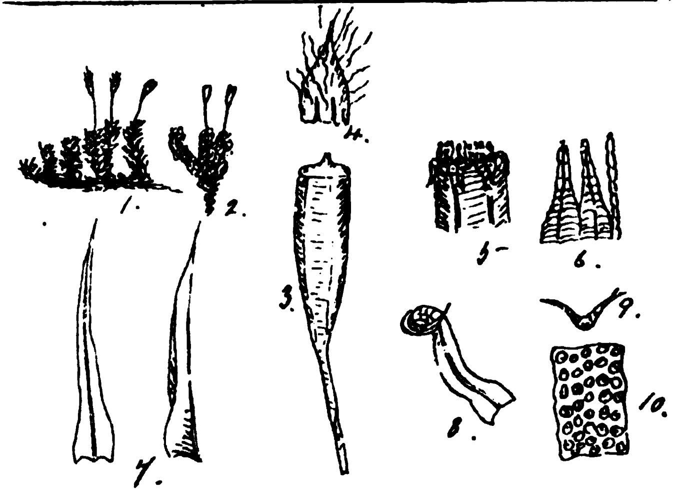




L R del.

Pl. V.





L.R. del.

DESCRIPTION OF A NEW SPECIES OF SHARK.

By Alex. Morton.

During the month I had brought to the Museum a peculiar-looking fish, having been found washed up on the beach at Bruny Island. On examination it proved to be a species of *Centrina*; at first I was inclined to believe it was *C. salviani*, but on closer examination it seemed to differ. A specimen of *C. salviani* having been found off the coast of New Zealand some few years back, I had a photo. of the Tasmanian specimen sent to Professor Hutton, F.R.S., Curator Canterbury Museum, Christchurch. Professor Hutton wrote, stating that, judging from the photo., he was inclined to think that the Tasmanian Centrina differed from the one in New Zealand, which he considered was *Centrina salviani*. Before finally deciding on making a new species, Mr. Ogilby, the able Ichthiologist of the Australian Museum, kindly undertook to compare the Tasmanian shark with the *C. salviani* in the Sydney Museum. After a careful examination, Mr. Ogilby wrote, saying "that the enormous height of the dorsal fins, and their contiguity, the one to the other, separates this species at a glance from *C. salviani*; the scales also differ considerably." I am very much indebted to Mr. Ogilby for his kindness in examining and furnishing me with the description. I propose giving it the specific name of *bruniensis*.

CENTRINA.—Each dorsal fin with a strong spine. Trunk rather elevated, trihedral, with a fold of the skin running along each side of the belly. Teeth of the lower jaw erect; triangular, finely serrated; those of the upper slender, conical, forming a group in front of the jaw. Spiracles wide, behind the eye.

Two species, *Centrina salviani* from the Mediterranean and neighbouring parts of the Atlantic and New Zealand. *C. bruniensis*, Tasmanian coast.

Centrina bruniensis, Morton.

Body oblong, with the back and sides rounded, and the belly flattened. Head small and strongly depressed, its breadth equal to the distance between the tip of the snout and the spiracle; snout short and obtuse, the distance between its tip and the nearest point of the mouth less than that between the same and the anterior margin of the eye. Nostrils equidistant from the eye and the extremity of the snout. Eye large, with a strong bony supraorbital ridge, situated midway between the tip of the snout and the anterior gill-opening. Spiracles large, opening behind the upper half of the eye, with a moderate intervening space. Mouth small and transverse, with the lateral groove very broad and deep. Upper jaw with a patch of small, conical, curved teeth anteriorly, consisting of about four irregular rows; a single series of much larger, erect, compressed, minutely serrated, scalpriform teeth in the lower jaw. Gill-openings small, the posterior one pierced immediately in front of the base of the pectoral fin. The first dorsal commences above the middle gill-opening, and rises by a continuous and equal gradation to the spine, its outer margin being straight; behind the spine the rise is much more abrupt, and the contour is slightly convex with the tip rounded; the posterior margin is deeply concave; the height of the fin beneath its extremity is equal to the distance between the anterior gill-opening and the tip of the snout, that of the spine equal to the head in front of the spiracle; the spine is situated in the anterior portion of the last fourth of the base of the fin, is perfectly straight, with a slight inclination forwards, and protrudes a short distance beyond the membrane; its base is exactly midway between the tip of the snout and the origin of the caudal, while the distance between the bases of the two dorsal spines is but little more than the length of the base of the first dorsal in front of its spine, and five-sevenths of the length of the fish in front of it; the intradorsal ridge is very strongly developed; the second dorsal has a general resemblance in shape to the first, but is not so large; the upper margin is more regularly even, and the extremity, which is much more pointed, hangs vertically above the base of the caudal, instead of falling within the vertical from its own base, as with the anterior fin; the length of its base is equal to that of the intradorsal space, and to the height of the fin beneath its tip, and is four-sevenths of the outer margin; the spine is situated in the latter portion of the anterior half of the fin, and is gently curved backwards throughout its entire length; in height it is but little less than that of the first dorsal; the pectoral fin is well developed and pointed, its length equal to the space which divides its anterior basal margin from the nostril; the distance between its base and that of the ventral is two-fifths longer than that between the dorsal spines, and is traversed by a strongly developed lateral ridge; the ventral fin commences beneath the spine of the second dorsal, and the distance between its termination and the origin of the lower caudal lobe is equal to that between the second dorsal and the caudal fin; the caudal lobes are well developed; the outer margin of the upper lobe is straight, the angle and the posterior margin rounded; the lower lobe is triangular, with the anterior margin slightly concave, and equal in length to the posterior margin, which is sinuous, with the angle rounded. The skin is covered with small rough scales, each of which bears a well developed spinate projection, which consists of a central spine from which radiate four compressed wings, each one terminating at its outer angle in a somewhat shorter spine than the central one.

Colour.—Uniform sandy brown. Type specimen in the Tasmanian Museum, Hobart.

NOTES ON TASMANIAN LICHENS.

By John Shirley, B.Sc. (Lond.), Inspector of Schools, Queensland, Cor. Mem. Roy. Soc. Tasmania.

During my visit to Tasmania in January last, to attend the annual meeting of the Australasian Association at Hobart, I took such opportunities as offered themselves to make a collection of the lichens of the island; and hearing from Mr. W. A. Weymouth that he had a small collection of these lowly yet lovely plants, I was kindly permitted to look through his gatherings, and to select some 40 specimens of such as appeared rare and worthy of microscopic examination. The examination of a lichen in all its parts by the aid of a microscope is a work requiring considerable time and patience; but a still more time-consuming labour is the examination of the multitudinous and fragmentary works on lichenology, which must be undertaken when a species is believed to be new to science. Every care has been taken, but should an older and more experienced lichenologist detect errors in my work, then "*Magna est veritas et prevalebit.*"

LICHENES.

Order I.—Collemaceæ, *Müll. Arg.* Enum. Lich. Gen., p. 18, et Lich. Socot.

Tribe I.—Collemeæ, *Körb.*, Par. p. 408.

Leptogium chloromelum v. granulare, *Müll. Arg.* On mossy stones, Mt. Wellington, W. A. Weymouth, No. 123.

Order II.—Epiconiaceæ, *Müll. Arg.*, Enum. Lich. Gen. et Lich. Socot.

Tribe II.—Caliciеæ, *Müll. Arg.*, Enum. Lich. Genéve, p. 19.

Calicium Victoriæ, *C. Knight.* On decorticated tree, Falls Track, Mt. Wellington, W. A. Weymouth, No. 132.

Order III.—Lichenaceæ, *Müll. Arg.*, Lich. Socot. et Enum. Lich. Gen.

TRIBE III.—SPHÆROPHOREÆ, *Fr.*, Lich. Europ., p. 403.

Sphærophoron compressum, *Ach.* Mt. Wellington, J. Shirley, No. 57.

„ coralloides, *Pers.* Mt. Wellington, on earth, J. Shirley, No. 71; on wood, Tasman Peninsula, W. A. Weymouth, No. 35.

„ fragile, *Pers.* Mt. Wellington, J. Shirley, No. 44.

„ tenerum, *Laur.* Newman's Creek, Tasman Peninsula, W. A. Weymouth, No. 18; and Mt. Wellington, J. Shirley, No. 51.

TRIBE IV.—BÆOMYCEÆ, *Müll. Arg.*, Lich. Cath., p. 7.

Bæomyces heteromorphus, *Nyl.* On rock and earth, St. Crispin's, W. A. Weymouth, Nos. 107 and 120.

TRIBE V.—CLADONIEÆ, *Müll. Arg.*, Lich. Gen., p. 22.

Stereocaulon ramulosum, *Ach.* Mt. Wellington, J. Shirley, No. 56.

„ proximum v. macrocarpoides, *Nyl.* Mt. Wellington, J. Shirley, Nos. 48 and 50.

Clathrina aggregata, *Müll. Arg.* Mt. Wellington, J. Shirley, No. 55 (a); and Huon Road, Hobart, W. A. Weymouth, No. 136.

„ schizophora, *Mull. Arg.* On dead eucalyptus stump, Lauriston Rivulet, Kangaroo Point, Tasmania, W. A. Weymouth, No. 108; and Mt. Wellington, J. Shirley, No. 55 (b).

Cladonia sylvatica v. pycnoclada, *Del.* Oyster Cove, Tasmania, W. A. Weymouth, No. 137.

„ squamosa v. acuminata, *Ach.* Falls Track, Mt. Wellington, W. A. Weymouth, No. 135.

„ rangiformis, *Hoffm.* Falls Track, Mt. Wellington, W. A. Weymouth, No. 134.

„ verticellata, *Flk.* Mt. Wellington, J. Shirley, No. 54.

„ pyxidata, *Fr.* Mt. Wellington, J. Shirley, No. 52.

„ „ v. neglecta, *Tuck.* Huon Road, Hobart, W. A. Weymouth, No. 129.

„ delicata v. subsquamosa, *Nyl.* On decaying wood, St. Crispin's, Mt. Wellington, W. A. Weymouth, No. 109.

„ fimbriata v. radiata, *Fr.* Mt. Wellington, J. Shirley, No. 47.

„ fimbriata v. carneo-pallida, *Ach.* Mt. Wellington, J. Shirley, No. 53.

Cladonia cornucopioides, *Fr.* Falls Track, Mt. Wellington, W. A. Weymouth, No. 121. Ploughed Field, Mt. Wellington, J. Shirley, Nos. 43, 46, 49.

„ deformis, *Hffm.* Mt. Wellington, on summit, J. Shirley, No. 45.

TRIBE VI.—USNEÆ, *Müll. Arg.*, Bot. Socot., p. 349. Th. M. Fries, Gen. Heterolich., p. 47.

Usnea dasypogoides, *Nyl.* Mt. Wellington, J. Shirley, No. 65.

TRIBE VII.—PARMELIEÆ, *Müll. Arg.*, Lich. Génev., p. 31.

Stictina cinnamomea, *Rich.* Mt. Wellington, J. Shirley, No. 58.

Sticta Freycinetii, *Del.* Bower Creek and St. Crispin's, W. A. Weymouth, Nos. 116 and 128.

„ dissimulata, *Nyl.* Falls Track, Mt. Wellington, W. A. Weymouth, No. 123.

„ fossulata, *Duf.* Mt. Wellington, J. Shirley, No. 64 (a).

„ „ v. physciospora, *Nyl.* Mt. Wellington, J. Shirley, No. 64 (b,)

Parmelia tenuirima, *Tayl.* Mt. Wellington, J. Shirley, No. 62.

„ olivacea, *Ach.* Mt. Wellington, J. Shirley, No. 60.

„ pertusa, *Schrank.* Mt. Wellington, J. Shirley, No. 61.

„ physodes, *Ach.* Mt. Wellington, J. Shirley, No. 63.

„ „ v. placorhodioides, *Nyl.* Mt. Wellington, J. Shirley, No. 59.

Theloschistes parietinus, *Norm.* On rocks, Bellerive, Kangaroo Point, W. A. Weymouth, No. 126.

TRIBE VIII.—PSOROMEÆ *(Fr.), Nyl.*

Psoroma sphinctrinum, *Nyl.* Pedder's Gully, Kangaroo Point, W. A. Weymouth, No. 1.

„ sphinctrinum v. pholidotoides, *Nyl.* Mt. Wellington, J. Shirley, No. 66.

TRIBE IX.—PLACODIEÆ, *Müll. Arg.*, Lich. Gen., p. 37.

Placodium gelidum, *Körb.* Mt. Wellington, No. 139, W. A. Weymouth, and No. 67, J. Shirley.

TRIBE X.—LECANOREÆ, *Müll. Arg.*, Bot. Socot., p. 359.

Callopisma cinnabarina, *Müll. Arg.* On rocks, Bellerive, Kangaroo Point, W. A. Weymouth, No. 127.

TRIBE XI.—LECIDEÆ, *Müll. Arg.*, Lich. Gen., p. 50.

Biatora immarginata, *R. Brown.* St. Crispin's, W. A. Weymouth, No. 104.

„ russula, *Ach.* Huon Road, W. A. Weymouth, No. 124.

„ cera-rufa, *Shirley*, sp. nov. Thallus sordid white, thin opaque, sub-pulverulent, effuse; apothecia ·5 mm., with white waxy margin, entire or flexuous, and plane rufous disk; hypothecium pallid; spores 8, colourless, simple, ·013—·015 × ·006 mm.; paraphyses colourless, thickish, glutinated. On bark, Bower Track, Mount Wellington, W. A. Weymouth, No. 141.

Patellaria (Psorothecium) melanotropa, *Nyl.* On bark, St. Crispin's, W. A. Weymouth, No. 119.

Patellaria (Psorothecium) Taitensis, *Mnt.* On bark, New Town Rivulet, and St. Crispin's, Mt. Wellington, W. A Weymouth, Nos. 138 and 154.

Patellaria (Psorothecium) biclipea, *Shirley*, sp. nov. Thallus sordid-glaucous, thin, effuse, smooth, opaque, sparingly diffract; apothecia small, ·5—1 mm., numerous, not crowded, when young with distinct, entire, concolorous margin, and concave, suffused disk; when mature plano-convex, and margin obscured, aquose-fuscous to nigro-fuscous, and often parti-coloured; lamina and hypothecium fuscescent; spores 8, 2-locular, colourless, oval, straight or curved, 16—20 μ × 5—6 μ; paraphyses short, thick. On bark, St. Crispin's, W. A. Weymouth, No. 155 (a).

Near *Patellaria Taitensis*, *Mnt.*, but spores much smaller and more acutely pointed; allied also to *P. grossa*, *Pers.*, but lamina not hyaline.

Patellaria (Bacidia) Weymouthii, *Shirley*, sp. nov. Thallus sordid white or pallid-sordid-flavescent, thin, shining, speckled over with black spermagonia, bordered by a nigro-fuscous zone; apothecia to 1 mm., nigro-fuscous, from plane and marginate to convex and shapeless, when young immersed and the disk thalline clothed; hypothecium fuscous; spores acicular, colourless, ·026—·03 × ·002—·0025 mm., 1-∞-septate, at both ends acute, curved; paraphyses clavate, delicate, separating. On bark, St. Crispin's, W. A. Weymouth, Nos. 112, 115, 131.

Buellia disciformis, *Fr.* On willow, Hobart Rivulet, W. A. Weymouth, No. 122.

„ parasema, *Th. Fr.* On bark, Huon Road, W. A. Weymouth, No. 125.

„ polospora, *Leigh*, v. asperata, *Shirley*, var. nov.

This lichen has the thallus and spores of the type, but the apothecia are fringed with granular asperities, giving them at first sight a resemblance to *L. leucoblephara, Nyl.* On bark, Fork Creek, W. A. Weymouth, No. 144.

Blastenia consanguinea, *Mull. Arg.* Bears considerable likeness to *B. ferruginea v. cinnamomea, Fr.*, but the spores are larger. St. Crispin's, on bark, W. A. Weymouth, No. 106.

Heterothecium pauciseptatum, *Shirley*, sp. nov. Thallus white or pallid glaucous, in glebulæ, or fine, rounded, pallid greenish, pulverulent ridges, effuse; apothecia to 2 mm., fuscous; when young with plane disk, and a thin, very slightly prominent, pale brown margin; when mature slightly convex and immarginate; hypothecium and lamina white or pallid; spores 2—3, colourless, 3—5 septate, with 1—3 cellules in each cell, ·04—·05 x ·02 mm.; paraphyses coarse. On bark, Bower Creek, Mt. Wellington, W. A. Weymouth, No. 142.

TRIBE XII.—CŒNOGONIEÆ, *Müll. Arg.*, Lich. Parag., p. 18.

Cœnogonium acrocephalum, *Müll. Arg.* So named from the capitate paraphyses. On moss, Henty River, W. Coast, and St. Crispin's, Mt. Wellington, W. A. Weymouth, Nos. 140 and 117.

TRIBE XIII.—GRAPHIDEÆ, *Müll. Arg.*, Graph. Fee, pp. 4 and 13.

Arthonia multiformis, *Shirley*, sp. nov. Thallus thin, flavescent, smooth, sub-continuous; ardellæ very numerous, small, various, from punctiform to 1 mm., difformate, rufo-nigro-fuscous; spores 8, pupa-shaped, 3—6 locular, 30 x 6 μ, terminal loculi largest, and these unequal, the 1—3 central loculi broader in transverse diameter, appressed, and constricted at the septa; occasionally the smaller of the polar loculi is again transversely divided. On bark, Springs, Mt. Wellington, W. A. Weymouth, No. 111.

Chiodecton perplexum, *Nyl.* On bark, St. Crispin's, W. A. Weymouth, No. 118.

TRIBE XIV.—PYRENULÆ, *Müll. Arg.*, Pyr. Cub., p. 375.

Pseudopyrenula galactina, *Shirley*, sp. nov. Thallus white' opaque, thinly crustaceous; apothecia of a single very small perithecium, thalline veiled and concolorous, with minute punctate ostiola, then delapso-urceolate and revealing the black pericarp; spores colourless, 4-locular, ovoid, ·018—·02 × ·006—·009, 1—seriate in a narrow ascus; paraphyses delicate. On bark, St. Crispin's, W. A. Weymouth, No. 113.

Pyrenula chloroplaca, *Shirley*, sp. nov. Thallus flavid, smooth, shining, thin, nigro-marginate, apothecium of a simple small perithecium, lower half thalline clothed and innate, upper half hemispherical, black, nigro-ostiolate; spores brown, 2—4 locular, loculi lenticular, ·008 × ·004 mm., elliptical. In a direct light the two terminal cells are often invisible, being close to the apices. On bark, St. Crispin's, and the Springs Track from Fern Tree, W. A. Weymouth, Nos. 114 and 161.

TESTING MINERAL SPRINGS (Abstract).

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By the Bishop of Tasmania.

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By Alex. Morton.

TAXATION AND COST OF LIVING IN TASMANIA (Abstract).

By R. M. Johnston, F.L.S.

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CONTENTS.

A

Page
April Meeting ... I
Adye Douglas, Hon. ... II
Antarctic Exploration ... III
Arctic Research ... III
Antarctic World ... III
Antarctic Regions ... IV
Arctic Seas ... IV
Antarctic Expedition ... V
American Astronomers ... VI
Admiral Bowden-Smith ... VII
Ancient Wrecks and Relics of European Vessels on Australian Coasts ... XII
August Meeting ... XIII
Agnew, Hon. Sir J. W.. ... XIII
Australasian Association for the Advancement of Science, Brisbane Meeting ... XIII
Australasian Association for the Advancement of Science, Adelaide Meeting ... XVI
Aryan Races ... XVIII
Agnew, Sir James Wilson, May Meeting, 1895 ... XX
Adamson's Range ... XXI
August Meeting, 1895 ... XXII
Alluvial Drift at Swansea ... XXII
Adzes, New Guinea ... XXIII
Adams, Mr. O. ... XXIII
Agnew, Sir James Wilson, October Meeting, 1895 ... XXVII
Apologies, October Meeting, 1895 ... XXVII
Adjourned Meeting, 1895 ... XXIX
Abel Jansen Tasman ... XXXII
Anthony Van Diemen ... XXXII
Amsterdam ... XXXII
Attorney-General (Hon. A. I. Clark) ... XXXIV

B

Barnard, James, Mr. ... I
Bednall, Mr. W. F. ... II
Bowden-Smith, Admiral ... VII
Baron Von Müeller ... IX
Bernard Shaw, Mr. ... XV
Braddon, Sir Ed. N. C. ... XVI
Brown, Prof. W. Jethro ... XVIII
Beattie, Mr. J. W. ... XIX
Bohemia ... XX
Botany of the Harts and Adamson Ranges ... XXI
Bicheno ... XXII
Bog Oak ... XXII
Bimetalism ... XXVII
Benjafield, Dr. ... XXIX
Brisbane Weather Bureau ... XXX
Brown, Hon. N. J. ... XXXI

B

Page

Beattie, Mr. J. W., Lantern Slides ... XXXIII
Ben Nevis Observatory ... XXXIV
Balfour, Capt., R.N. ... XXXIV
Black Swans ... XXXV
Bass Straits ... XXXVI

C

Chitons, Tasmanian, (a Paper) ... II
Crawford, Capt. Pascoe, R.N. ... III
Challenger Expedition ... IV
Cook, Capt. ... V
Cust, Capt., R.N., H.M.S. "Dart" ... VI
Correct Time ... VII
Connaissance des Temps ... VIII
Counsel, Mr. E. A. ... IX
City of Hobart... ... IX
Centrolepis, a New (a Paper)... ... XII
Commissioniers of Fisheries ... XV
Chalmers, Rev. Jas. ... XV
Col. Cox ... XV
Czernowitz University ... XXI
Cambria Estate ... XXII
Cuculus flabelliformis ... XXIII
Continent, Australian... ... XXIII
Chalmers, Rev. Jas. ... XXIII
Cape York Peninsula ... XXX
Cooktown ... XXX
Chief Weather Bureau, Queensland... ... XXX
Cape of Good Hope ... XXXII
Ceylon and Japan ... XXXII
Campbell Island ... XXXVII

D

Dicker, Rev. C. W. H. ... II
December, 1893 ... VI
Douglas, Hon. Adye ... VI
"Dart," H.M.S. ... VI
Deputation Appointed (Fur Seals) ... XVII
Dobson, Sir Lambert ... XVIII
Dobson, Hon. Henry ... XIX
Dunedin University ... XX
Drift, Alluvial, at Swansea ... XXII
Death of Mrs. Charles Meredith ... XXIX
Douglas, Hon. Adye ... XXXIII
Deputation (Fur Sealing) ... XXXVI

E

Excellency Lord Gormanston ... I
Erebus and Terror ... IV
Ellery, Mr. R. J., Govt. Astronomer, Victoria ... VIII
Eucalyptus, a New ... IX
Eucalyptus, Described in 1886 ... IX
Eucalyptus, *mullerii* ... IX
European Exporter (Tasmanian Timber) ... XI
Economic Price ... XXV
Economic Changes, Recent ... XXVI
East Indies ... XXXII

CONTENTS.

F

Page
Franklin, Sir John ... III
Franklin, Lady... IV
Fincham, Mr. Jas. ... XIII
Further Discoveries of Glaciation ... XIII
Fauna, Native ... XVI
Fur Seal, Protection of the ... XVI
Fur Seal in Bass Straits ... XVII
Fur Seal on Macquarie Island... XVII
Fur Seal Deputation to the Government ... XVII
Fitzgerald, Mr. ... XX
Further Proofs of Glaciation... XXI
Foxwell, Prof., of Cambridge ... XXIX
Frieslander ... XXXII
Fauna, Native, Preservation of ... XXXV
Fur Seals, Preservation of ... XXXVI
Fisheries Board ... XXXVI

G

Gormanston, His Excellency Lord ... I
Gothenburg System ... I
Government, British ... I
Geographical Societies, Royal ... III
Geographical Society of England ... IV
Greene, Mr. A. Osborn, on Tasmanian Timber ... X
Goose Island ... XIII
Glaciation on the West Coast ... XIII
Government, New Zealand ... XV
Guinea, New ... XV
Grant, Hon. C. H., September Meeting ... XVI
Game Acts ... XVI
Geographical Names, Orthography of ... XVII
Geeveston ... XIX
Guinea, New, Stone Adzes ... XXIII
Giffen, Sir Robert ... XXIX
Game Act ... XXXVII

H

Hogben, Mr. Geo. ... V
Henry, Mr. Robert ... XIII
Hemisphere, Southern ... XVIII
Hartz Mountains ... XIX
Hartz and Adamson's Range... XXI
Harvey's Creek ... XXI
Henry, Hon. John ... XXVII
Hawson, E., Mr. ... XXVII
Hewitt, Mr. T. E. ... XXVII
Hollanders ... XXXII

I

Important Geographical Discovery in the Antarctic Regions ... IV
Italy, Timber from ... XI
India ... XV
Israel, Mr. J. W. ... XXXI

CONTENTS.

J

Page

Jason, Norwegian Schooner ... IV
Johnston's, Mr. R. M., Remarks ... V
June Meeting, 1894 ... VI
July Meeting, 1894 ... X
January (Sealing) ... XV
Jethro-Brown, Prof. W., M.A., LL.D. ... XVIII
Johnston, Mr. R. M., Vote of Thanks to ... XVIII
Johnston, Mr. R. M., Primary Law of Value, &c. ... XXV
Johnston, Mr. R. M., Vote of Thanks to ... XXVI
Johnston, Mr. R. M., Paper Discussion ... XXVII
Japan and China ... XXXII

L

Larsen, Capt., of the schooner Jason ... IV
Louis Phillipe ... IV
Lady Franklin ... IV
Larsen, Capt. ... V
London Builder ... XI
Lands Department ... XVII
Lendenfeld, Prof., R.N. ... XXI
Lyne Sugar Loaf Range ... XXII
Law of Value or Price ... XXV
Life and Times of Tasman ... XXXII
Lantern Illustrations ... XXXIII

M

Mobeek, Dr. E. E. ... I
Macnaughten, Mr. R. ... I
Minister, Report of British ... I
Moebeek, Dr., Remarks ... I
Mault, Mr. A. (Paper) ... II
Mault, Mr. A. (Paper, Antarctic) ... III
Murray, Dr., Challenger Expedition ... III
Morton, Mr. A., Challenger Expedition ... III
Murray, Dr. (Paper) ... IV
Meridian Mark on Mt. Nelson ... VII
Mault, Mr., Local Triangulation ... VII
Müeller, Baron Ferd ... IX
Mt. Wellington ... IX
McClymont, Mr. J. R. (Paper) ... XII
McAulay, Prof. A. ... XIII
Moore, Mr. T. B. (Paper) ... XIII
Montgomery, Bishop (Paper) ... XIII
Maclaine, Mr., of Clarke Island ... XIV
Macquarie Island ... XV
Madras Presidency ... XV
Main Schouten ... XVI
McClymont, Mr. J. R. (Paper) ... XVII
Method of Dropping Time Ball ... XVIII
Mountains, Harts ... XIX
May Meeting, 1895 ... XX
Mineral Substance New to Tasmania ... XX
Moore, Mr. T. B. (Paper) ... XXI

CONTENTS.

M

Page
Meredith River ... xxii
Meredith, Mr. ... xxii
Murray ... xxiii
McCluskey, Mr., Spring Bay ... xxiii
Morris, Mr. F. ... xxiii
Moore, Mr. T. B. (Paper) ... xxiii
Meredith, Mrs. Chas., Water Colours ... xxvii
Meredith, Mrs. Chas., Death of ... xxix
Mount Wellington ... xxx
Mosses, New (Paper) ... xxxii
Macquarie Harbour ... xxxiii
Mt. Wellington as a Meteorological Station ... xxxiv
Meteorological Observer ... xxxiv
Moulting Lagoon ... xxxv
Moore, Hon. W. ... xxxv
Montgomery, Bishop ... xxxv
Morton, Mr. A. ... xxxvi

N

New Species of Pedalion ... ii
Norwegian Schooner Jason ... iv
Natica mollusca ... iv
Navy Royal ... v
North Pole Star ... vi
New *Eucalyptus* ... ix
Norway and Sweden ... xi
New Method of Dropping Time Ball ... xiii
New Zealand Government ... xv
New Guinea Ethnological Specimens ... xv
Native Fauna, Protection of ... xvi
Notes on a Recent Trip to the Hartz Mountains ... xix
Notes on a Mineral Substance New to Tasmania ... xx
New Fossil Plants to Tasmania ... xxi
New Guinea Stone Adzes ... xxiii
Nicholson, Professor, of Edinburgh ... xxviii
Northern Queensland ... xxx
New Botanical Specimens ... xxxii
New Mosses ... xxxii
New Zealand, Tasman ... xxxiii
Nevis, Ben ... xxxiii
Native Fauna, Protection ... xxxvi
North East Coast ... xxxvi
New South Wales ... xxxvii

O

Osborne, Capt. Sherard, R.N. ... iv
Observatory, Hobart ... vi
Octantes, 1893 ... vi
Observatory, Melbourne ... viii
Observatory, Royal, Greenwich ... viii
Osborn Greene, Mr. A. ... x
Orthography of Geographical Names ... xvii
Œdicnemus grallarius ... xxiii
Oyster Bay Pine ... xxiii
Ogilvy, Mr. A. J. ... xxvii
Observer, Meteorological ... xxxiv

CONTENTS.

P

Page
Penguin, H.M.S. ... I
Pedalion, on a New Species of ... II
Pascoe, Crawford, Capt. ... III
Polar Regions ... IV
Polar Area ... IV
Pole, North ... IV
Phœnicia ... VI
Pury Cust, Capt., R.N. ... VII
Portugal ... XI
Protection of Mutton Birds and Seals ... XIII
Protection of Native Fauna ... XVI
Protection of Cape Barren Goose ... XVI
Protection of Fur Seal ... XVI
Protection of Bass Straits and Macquarie Island ... XVII
Papua, Voyages to ... XVII
Primitive Theories of Political Teaching, Prof. Brown ... XVIII
Petterd, Mr. W. F., New Mineral ... XX
Plover, Southern Stone ... XXIII
Proofs of Glaciation at Low Levels ... XXIII
Primary Law of Value or Price ... XXV
Peninsula, Cape York ... XXX
Primary Law of Value or Price ... XXX
Penguin, H.M.S. ... XXXIV
Preservation of Fur Seals ... XXXVII

R

Robjohns, Rev. T. ... I
Rule, Mr. Jas. ... II
Ross, Sir James ... III
Ross and Weddell ... III
Royal Navy ... III
Royal Geographical Society of England ... IV
Royal Society of New South Wales ... XXII
Ricardo ... XXIX
Reibey, Hon. Thos., M.E.C., Election ... XXX
Rodway, Mr. Leonard ... XXXII
Raleigh, Sir Walter ... XXXII
Russell, Mr., Observatory, Sydney ... XXXIV
Royal Society and the Fisheries Board ... XXXVII

S

Sweden, (Dr. E. E. Mobeek) ... I
Surgeon, V. G. Thorpe, R.N., F.R.M.S. ... I
Surgeon, V. G. Thorpe, R.N., F.R.M.S. (Paper) ... II
Solomon Islands ... II
South Atlantic ... III
Scottish Geographical Society ... IV
Scotch and Norwegian Whalers ... IV
Sherard, Osborne, Capt., R.N. ... IV
Stars, List of ... VIII
South Polar Stars ... VIII
Shirley, Mr. J., Brisbane ... XIII
Straits Islands ... XIII
Sheveroy Hills, Madras Presidency ... XV

CONTENTS.

S

Page
September Meeting ... XVI
Schouten Main ... XVI
Southern Hemisphere ... XVIII
Silver Queen Prospecting Association ... XX
Stitt, Mr. J. G. S., of Zeehan ... XX
System of Mineralogy (Dana's) ... XX
Stitt, Mr. J. G. S. ... XXI
Strahan-Lyell Road ... XXI
Swansea, Alluvial Drift at ... XXII
St. Paul ... XXII
Swan River ... XXII
Southern Stone Plover ... XXIII
Swansea (Mr. F. Morris) ... XXIII
Strahan and Pine Cove ... XXIII
Stone Adzes, New Guinea ... XXIII
September Meeting, 1895 ... XXV
Sir Walter Raleigh ... XXXII
Spice Islands ... XXXII
Spain and the Spaniards ... XXXII
South Land Gnat ... XXXIII
South Australia ... XXXIV
Sydney Observatory ... XXXIV
Swans, Black ... XXXV
Sealing in Bass Straits ... XXXVI

T

Thorpe, Surgeon V. G., R.N. ... I
Tasmania, Bishop of ... I
Tasman's Tracks ... II
Tasmanian Chitons (a Paper) ... II
Thorpe, Surgeon (a Paper) ... II
Tasmanian Earthquakes (a Paper) ... V
Transit Instruments ... VI
Transit at the Hobart Observatory ... VII
Transit of Venus Expedition ... VIII
Tramway Company ... IX
Tasmanian Timbers (their uses, etc.) ... X
Tasmanian Trees ... X
Tasmanian Woods ... XI
Tasmanian Sealers ... XV
Tasmanian Fur Seals ... XV
Time Ball, Dropping the ... XVIII
Theories of Political Teaching (a paper) ... XVIII
Tasmanian Scenery ... XIX
Tasmania, New Fossil Plants to ... XXI
Tasman, Abel Jansen ... XXXII
Tasman, Birth of ... XXXII
Tasman's Family ... XXXII
Tasman's Marriage ... XXXII
Tasman on Service ... XXXII
Tasman's Command of Ships ... XXXII
Tasman's Punishment ... XXXIII

U

Ulrich, Prof. G. H. F. ... XX
University, Czernowitz ... XXI

CONTENTS.

W

Page
Weddell III
Weddell, Mr. Jas. VI
West Coast XXII
Wealth, Cosmopolitan XXV
Watercolour Drawings, Mrs. C. Meredith XXVII
Wragge, Mr. Clement XXX
Weymouth, Mr. W. A. XXXII
Western Australia XXXIII
Wellington, Mount XXXIV
Wragge's, Mr., Recommendations XXXIV

CONTENTS.

PAPERS, 1894.

Page

1. The Deportation of the Norfolk Islanders to the Derwent in 1808, by James Backhouse Walker 1
2. The Gothenberg System, by Mr. Russell MacNaughton, Communicated (Abstract) I
3. Note on a MS. Chart in the British Museum, showing Tasman's Tracks in the voyage of 1642-4 (Charts), by A. Mault 27
4. On Some Tasmanian *Chitons*, by W. H. Bednall (Corresponding Member) 34
5. Notes on Some River Ouse Fossil Impressions, by Rev. C. W. H. Dicker (Abstract) II
6. Notes on a New Species of Pedalion from the Solomon Isles, by V. G. Thorpe, M.D., R.N., F.R.M.S. 40
7. On Antarctic Exploration, by A. Mault 42
8. Tasmanian Earthquakes of 1892, by Geo. Hogben (Abstract) V
9. Meridian Observations with the Hobart Transit Instruments, by H. C. Kingsmill, M.A. VI
10. Notes on Some New and Rare Tasmanian Plants, by Leonard Rodway 51
11. Tasmanian Timbers, their Commercial Worth and Preparation for Market, by A. Osborn Greene (Abstract) X
12. Ancient Wrecks and Relics of European Vessels on Australian Coasts, by J. R. McClymont, M.A. (Title), ... XII
13. A New Centrolepis, by Leonard Rodway (Plate) 55
14. Further Discoveries of Glaciation in Tasmania, by T. B. Moore, F.R.G.S. 56
15. The Protection of Mutton Birds and Seals, by the Bishop of Tasmania (Abstract) XIII
16. Early Voyages to Papua, 1511 to 1545, by J. R. McClymont, M.A. (Title) XVII
17. A New Method of Dropping the Time Ball, by Robert Henry (Abstract) XVIII
18. Primitive Theories of Political Teaching, by Professor W. Jethro-Brown, M.A., LL.D. (Title) XVIII
19. Notes on a Recent Trip to the Hartz Mountains, by J. W. Beattie (Title) XIX

CONTENTS.

PAPERS, 1895.

Page

20. Abel Jansoon Tasman: his Life and Voyages (Maps), by J. B. Walker, F.R.G.S. 1

21. Notes on a Mineral Substance New to Tasmania, by W. F. Petterd xx

22. Notes on Further Proofs of Glaciation at Low Levels, by T. B. Moore, F.R.G.S. xxi

23. Notes on Some Fossil Plants new to Tasmania, by R. M. Johnston, F.L.S. (Plates) 57

24. The Botany of the Harts and Adamson's Ranges, by Leonard Rodway 64

25. Notes on Timber Found Beneath Alluvial Drift at Swansea, by Col. W. V. Legge, R.A. 68

26. Notes on the Fan-tailed Cuckoo in Tasmania *(Cuculus flabelliformis)*, by Col. W. V. Legge, R.A. 70

27. Notes on the Occurrence of the Southern Stone Plover *(Œdicnemus grallarius)* in Tasmania, by Alex. Morton... 71

28. Proofs of Glaciation at Low Levels in Tasmania, by T. B. Moore, F.R.G.S. 73

29. The Primary Law of Value or Price (Diagrams), by R. M. Johnston, F.L.S. 74

30. Discussion on R. M. Johnston's Paper 98

31. On Some New Botanical Specimens, by Leonard Rodway ... 102

32. On the New Genus Petterdiana, by John Brazier, F.L.S., C.M.Z. Soc., London, Corr. Mem. Royal Soc. Tasmania 105

33. Notes on Some New Tasmanian Mosses, by W. A. Weymouth 106

ROYAL SOCIETY, 1894.

APRIL.

The 1894 session of the Royal Society was inaugurated on Monday, April 9. The President, His Excellency Lord Gormanston, presided. His Excellency formally welcomed Dr. E. E. Mobeek (Sweden), Surgeon V. G. Thorpe, F.R.M.S (H.M.S. Penguin), and Rev. T. Robjohns (Sydney), who were introduced by the Secretary (Mr. A. Morton).

THE GOTHENBERG SYSTEM.

The **Bishop of Tasmania** read a paper on "The Gothenberg System," communicated by Mr. Russell Macnaughten. The writer explained that the Gothenberg system was co-operation applied to licensing. The state or municipality, acting through a company, bound by certain conditions, set in the place of the publican (in licensed houses owned and managed by the company) officials receiving a fixed yearly salary with a bonus derived not from the alcohol, but from the food and non-alcoholic beverages they might be able to sell. This principle was of paramount importance. The inducement to push the sale of alcoholic liquor was stopped, because the publican was no longer anything but a salaried servant, and because the bonus he received was entirely dependent on the food and non-alcoholic beverages sold. In fact it became his interest to push their sale as far as possible to the exclusion of alcohol, the demand, for which was no longer stimulated by any artificial pressure on the part of the publican. The movement that resulted in the establishment of the Gothenberg system began in 1862. The Dean of Gothenberg took a prominent part, and, mainly owing to his exertions, a committee was appointed to investigate the reasons of pauperism and misery at that time very prevalent amongst the poorer classes of the town. The committee decided that it was "to brandy, and brandy alone," most of the sufferings of the working classes were due. A company was almost immediately formed to take over the existing licences of the town on the following conditions:—(1) That the amount of profit to be made by the shareholders should be limited to 6 per cent.; (2) the payment of managers by salary and commission on food and non-intoxicants; (3) satisfactory accommodation for the public as regards the situation, size, space, food, etc., of all the houses belonging to the company; (4) all the profits above 6 per cent. to be handed over to the municipality. The company reduced the 60 licences in existence to 43, one for every 1,093 inhabitants. The writer gave his experience in Gothenberg in 1888, where, in the week before Christmas, when the peasantry from the surrounding country districts poured into the town, and although it was market day, he did not see a single drunken man. The company's monopoly applied to spirits only, brandy being the favourite intoxicating beverage. The British Minister's report, drawn up specially for the British Government, entered a verdict, after a careful and unprejudiced observation, distinctly favourable to the system as a whole, special attention being called to the fact that both the consumption of spirits and the cases of *delirium tremens* treated in the hospitals showed a marked decrease.

Dr. **Mobeek** said he had always heard that Tasmania kept in the front line of civilisation. He could not understand why England had not yet accepted the Gothenberg system, and eulogistically testified to its beneficial operation in the town in Sweden where he had lived for 35 years.

Mr. **James Barnard** characterised the paper as very interesting, and said that the Gothenberg system appeared to have solved the problem of the existence of public-houses with the well-being of society.

The CHIEF SECRETARY (Hon. Adye Douglas) did not see where the good of the system came in. We had not in all Tasmania *delirium tremens* to the same extent it seemed to exist in Gothenberg. Day after day they could go round the city of Hobart and not only not expect to meet a lot of drunken people, but intoxicated people were not often met with. The writer appeared to have gone to Gothenberg and expected to meet a lot of drunken people, and did not. A few years ago a few drunken people might have been met with in Tasmania, but now we were a decidedly sober people. Why should not a public-house be the same as any other house, properly decorated and properly adjusted for the reception of people? Although the houses professed to sell bread in Gothenberg, they were really nothing but drinking places. It was the liquor that brought the profit. Increased sobriety was due to the progress of temperance principles throughout the world. So far as the Gothenberg system was described in the paper, he did not see any advantages in it.

Mr. A. J. TAYLOR thought the introduction of the system would confer a lasting benefit on the community.

Hon. C. H. GRANT, M.L.C., said that in Gothenberg it seemed to him the system was applied to a different set of circumstances, climatic and otherwise, than what prevailed in English speaking communities.

The PRESIDENT said he was not prepared to give any opinion on the question, not having studied it. Two points struck him. It would be a very pleasant thing to have the duty on wine in this colony reduced. Something was to be said for the Gothenberg system, which allowed a municipality to make money out of it, for if a little more money were spent on the streets of Hobart—(but more he would not say.

TASMAN'S TRACKS.

Mr. A. MAULT read a lengthy note on a MS. chart in the British Museum, showing Tasman's tracks in the voyage of 1642-4, and presented *fac-simile* copies of the original chart to the Society for reproduction in its "Proceedings."

Mr. J. B. WALKER said that the Society was indebted to Mr. Mault for his paper. After some remarks on the subject, Mr. Walker said he understood that a portrait of Tasman was on the way out to the Exhibition, and that if it were authentic and original it would be a pity to allow it to leave the colony, for if any part of the world ought to revere the name of Tasman surely it was the colony named after him.

TASMANIAN CHITONS.

A paper on "Some Tasmanian Chitons," by Mr. W. F. Bednall, Corresponding Member (Adelaide), was read.

RIVER OUSE FOSSIL IMPRESSIONS.

Rev. C. W. H. DICKER, with a view to drawing attention to what he believed to be some fossil impressions in the bed of the River Ouse, read an interesting paper on the subject.

The SECRETARY thought the specimens exhibited were more likely to be water ripples than fossil impressions.

Mr. JAMES RULE reminded the writer of the presence of she-oak trees in the neighbourhood.

A NEW SPECIES OF PEDALION.

Surgeon THORPE read some notes on a new species of Pedalion found in the Solomon Islands, and exhibited some microscopical specimens.

The PRESIDENT thanked the contributors of papers, and the proceedings terminated.

MAY.

The usual monthly meeting of the members of the Royal Society was held at the Museum on Monday, May 7, when the chair was occupied by the Hon. C. H. Grant, M.L.C.

Apologies were read from His Excellency the Governor and Mr. J. Barnard, vice-president, for non-attendance. The Secretary said it would be interesting to know that it was just 53 years this week since Mr. James Barnard, its senior vice-president, was elected to membership, his nomination being seconded by Sir John Franklin. With the exception of the period when he was visiting England, Mr. Barnard had seldom missed a meeting of the Council or the monthly gatherings during his more than half century of membership.

ANTARCTIC EXPLORATION.

Mr. A. **Mault** read a paper on Antarctic Exploration. The subject, he said, was no new one for the Society, as its founder was the hero of Arctic research, and one of its Fellows a distinguished explorer of the Antarctic world. Detailing Sir James Ross' account of a storm he encountered in the ice in 1842, the lecturer urged the great advantage it would be in all future explorations to have steam instead of sailing vessels engaged in the work. The most important work had been done by Weddell in 1823, and Ross in 1841 and 1842. Weddell crossed the deep basin of the South Atlantic, and had fairly open water. Ross' track took him across no such deep basin, but he also found what the former experienced, the warm underlying current of water, which had a temperature of 39deg. at 1,000 fathoms, against 30 for the surface. At his farthest south, Ross found the warm water at the surface with a temperature of 32deg. against an atmospheric temperature of 27deg., and a sea bottom temperature at 250 fathoms of 33deg. The open sea to be met with in the south was held to be largely due to the existence of a line of seismic and volcanic action extending from New Zealand to Mount Erebus. The knowledge of the Arctic region was of little value in predication of the Antarctic conditions, the difference between the two, especially in regard to meteorology, being entirely and unaccountably different. The barometric pressure, for instance, was much less in the south than in the north by about half an inch of mercury. Then the Arctic region had a summer, but there was none in the Antarctic so far as was known. The variations of the thermometer were also very slight in the Southern Polar district. He quoted largely from papers read before the Royal Geographical Societies, and concluded by urging the advisability of prosecuting further researches in the Antarctic regions. Commercially speaking he left to others, although he felt that commerce always followed thorough scientific exploration. But the scientific interests were so important as to fully justify their being regarded as of such national concern as to require a special expedition. Tasmania in particular was interested in the matter of terrestrial magnetism observations, and he hoped that renewed attention would be given to the matter. His own opinion was that the exploration should be carried out by the Royal Navy, and if it were done then one of the vessels of the Australian squadron might very well be allowed to take part in it.

Captain **Pascoe Crawford**, R.N., said he was very interested in the paper and the subject matter, and quite concurred in the opinion that the work of Antarctic exploration should be carried out by the Royal Navy. There was a great deal to be done in the matter. In previous expeditions the ocean currents had been observed, and the result of the observations was of great value, but there was still a mass of evidence to be collected on the subject. As regards Tasmania and Australia, fresh and more elaborate information on the currents would be of much value meteorologically.

Mr. **Morton** said Dr. Murray, one of the members of the scientific staff that was on board the Challenger expedition, had recently read a paper before the Scottish Geographical Society entitled "Notes on an Important Geographical Discovery in the Antarctic regions." Dr. Murray stated that the most interesting discovery made by the whalers who last season visited the Antarctic Seas to the south of Cape Horn was that of the Norwegian schooner Jason, under the command of Captain Larsen. During a short visit to the shores of Seymour Island Captain Larsen picked up a good many fossils, which had fallen from a decomposing cliff. Some of these fossils were procured by Dr. Donald, and on critical examination they turned out to be specimens of *Cucullœa*, *Cytherea*, and *Natica mollusca*, similar to those found at Table Cape of the Tertiary period, together with some pieces of a coniferous tree. These fossils, Dr. Murray writes, are probably of lower Tertiary age, and indicate a warmer climate than now prevails in these high southern latitudes. Captain Larsen, Dr. Murray says, has again made a voyage in the Jason to the same waters as last year, and has made some highly important geographical discoveries—the most important made in the Antarctic regions since the time of Captain Ross in the voyage of the Erebus and Terror. In 1843 Ross spent nearly the whole season in attempts to penetrate the ice to the south and east of Louis Philippe and Jourville Land. Last year the Scotch and Norwegian whalers found the sea blocked in the same position. Captain Larsen this year found a comparatively open sea, and was able to proceed a considerable distance within the Antarctic Circle to the south of Louis Phillipe Island. Dr. Murray, in his able paper, states that statements with reference to currents show that they come from the south. Although the barometer is relatively low, as in the case of all the observations in these latitudes, still there is often bright weather, especially when the wind is from the south. So far as they go, Dr. Murray says these observations of Captain Larsen confirm the view that there is a large anti-cyclonic region overlying the Antarctic Continent. In a paper I read before this Society in 1890, entitled "What Science and Commerce may gain from an Antarctic Expedition," I said that until we know all that can be discovered as to the limit of pack ice, the extent of the Antarctic Continent, the influence of Mount Erebus, the distribution of flora and fauna, and the probabilities of successful whale fishing, there will be enough to gain, either from a commercial or scientific point of view, to make it worth while to send an expedition to the Antarctic regions. Further, I suggested that England and Australasia should unite in sending an expedition so equipped and manned that failure, if not impossible, should at least be unlikely. As far back as 1865, in a paper read before the Royal Geographical Society of England by Captain Sherard Osborne, R.N., C.B., an eminent authority on the Polar regions, said, "an exploration of the Polar area should always be sent under naval auspices and naval discipline. The navy of England cries not for mere war to gratify its desire for honourable employment or fame, there are other achievements it knows well as victorious battle. Upon these points, as well as those of scientific results, it would not be too much to ask for a fraction of the vast sum yearly sunk in naval expenditure for two small screw vessels and 120 officers and men, out of the 50,000 men annually placed at the disposal of the Admiralty." In a letter written by that noble lady, the late Lady Franklin, dated Madrid, April 6, 1865, the following passage occurs:—"For the credit and honour of England, the exploration of the North Pole should not be left to any other country. It is the birthright and just inheritance of those who have gone through 15 years of toil and risk in Arctic seas. The glory that yet remains to be gathered should be theirs." I think we may very safely add the words, Antarctic exploration. Dr. Murray concludes his very interesting paper as follows:—"The excursion of this small sealing schooner shows what large additions might in a short time be made to our geographical knowledge by a properly equipped expedition provided with steam power. If our Government would send for a British expedition, as is now being proposed, almost every branch of natural science would be enriched. Such an expedition must be accompanied by scientific men, and be fitted with all the apparatus of scientific investigations, or otherwise the expenditure and risk would hardly be justified. To determine the extent and nature of the land making up the Antarctic Continent, to penetrate into the interior of this continent, to ascertain the depth and condition of the ice cap, to take magnetic and meteorological observations on sea and land, to sound the ocean, to ascertain the temperature of ocean waters at all depths, to trawl up the animals on the sea floor, and to study the nature of the marine deposits; all this wou'd be the work of a modern British Antarctic expedition. It is earnestly demanded by the science of our day, and should be undertaken by the Royal Navy in the same way as the expeditions of Cook, of Ross, and of the Challenger. It is to be hoped that the scientific societies and the general public will soon urge this matter on the attention of our Government. It is evidently our duty to undertake this kind of work as in the past. If we do not do so, then it is good evidence that the present generation takes little interest in conquests over the powers of nature, and is little concerned in maintaining the maritime position and scientific reputation of this great empire."

With Dr. Murray's paper is an extract from the Jason's Journal, from November 15, 1893, to December 14 of the same year. Captain Larsen gives the weather from calm and sunshine to good strong northerly and westerly winds. They saw and captured several seals, saw what they describe many blue whales and grampuses. On the 6th December he describes the weather as having been nice and warm, also saw many birds and some small fish with large eyes.

Mr. R M. JOHNSTON also concurred in the necessity of the Royal Navy undertaking the work of exploration in the Antarctic Seas There were many problems to solve, especially in regard to the existence of pre-glacial vegetation in the regions as had been found in the Arctic sphere. It would be of very great scientific interest, and although it was to be feared that local governments might not be inclined to undertake the work for a year or so, still he hoped that it would not be long before such an expedition set out either from the shores of Tasmania or Australia.

The SECRETARY (Mr. Morton) submitted a paper prepared by Mr. George Hogben upon "Tasmanian Earthquakes of 1892," which was read.

JUNE.

The usual monthly meeting of the Royal Society was held on Monday, June 11, under the presidency of the Hon. C. H. Grant, M.L.C.

The SECRETARY (Mr. A. Morton) tabled a work entitled "A voyage towards the South Pole performed in the years 1822-24, containing an examination of the Antarctic Sea to the 74deg. of latitude," by James Weddell, Esq., presented by the Rev. J. B. W. Woollnough, M.A., M.H.A.; also "Papers and Proceedings of the Royal Society of Tasmania for 1893." The Secretary drew attention to an innovation in the latter volume, consisting of the inclusion of a form of bequest on the lines adopted by many leading scientific societies.

MERIDIAN OBSERVATIONS WITH THE HOBART TRANSIT INSTRUMENTS.

Mr. KINGSMILL said: The object of my paper is to bring under your notice a piece of astronomical work done at the Hobart Observatory, in the first instance by myself, and afterwards more completely by Captain Cust, of the Dart. This work was the determination of the meridian of the Hobart transit instrument by means of star observations taken with the instrument itself. The American astronomers determined a meridian with great accuracy when they came here on the transit of Venus expedition, and it would be possible to draw a parallel to it by offsets, as the Hobart Observatory is only 57ft. west of their meridian. But this method would be far less accurate than the determination of a fresh meridian by independent observations. There is a meridian mark for the Hobart transit instrument near Mount Nelson, just above the rifle range, and a little to the east of it. A stone something like a milestone has been erected in brickwork with a crosscut in it to indicate the exact meridian. When I came to the Observatory I was told that the cross was wrong, and that the true meridian was close to the eastern edge of the stone, but there was no record of the exact amount of the error. To obtain the exact local time it is necessary to find out all the errors of the instrument. It is by a number of small corrections that accuracy is obtained. However, this error appeared to require a pretty large correction. In December, 1893, I took some observations of the Southern Pole Star and Octantes which, satisfied me that the true meridian was clear of the stone altogether and to the east of it. It happened that there was an iron-dropper in a wire fence very nearly in the right position, and I used this as a temporary mark. It is perhaps not generally known that the Australasians have a pole star of their own considerably nearer to the Pole than the celebrated North Pole Star. But, unfortunately, we cannot see it with the naked eye. Still it can be seen with a telescope of very small power, and it affords an easy and accurate method of determining the meridian. Several other methods were adopted as a check, as follow:—The instrument was first carefully levelled and collimated, then set in a vertical position to observe a star passing directly overhead. It happens that in the latitude of Hobart several stars pass almost exactly overhead. One of these and Phœnicis are only 6sec. from the vertical. By observing the transit of a vertical star the exact time can be obtained with an instrument not in the true meridian. In that position the azimuth error has no effect. Having determined the true time in this way, Octantes, the pole star, was next observed, and followed with the middle wire of the instrument until the time he was due for his transit. Having by this and other methods made sure of the result I wrote to the late Chief Secretary (Hon. Adye Douglas), pointing out the necessity of having the transit instrument exactly in the line of the true meridian; that I had found by a number of star observations that the meridian mark was considerably out of the line, and that it would be necessary to shift the stone; that in its present position it was useless for the purpose for which it was intended, and asking that my observations as to the error, and calculations of its amount, might be referred to a practical astronomer for verification. The request was referred to Admiral Bowden-Smith, who replied that directions had been given for the Dart to comply with it. Captain Purey-Cust then came to the Observatory, and I placed everything at his disposal. After making a great number of observations he prepared the following report to the Commander-in-Chief of H.M. ships, Australia :—

Difficulty in Ascertaining Correct Time with Transit Instruments at Observatory, Hobart.—H.M.S. Dart, in Frederick Henry Bay, April 5, 1894. Sir,—In accordance with your memo of February 21 as to the above, I have the honour to report as follows :—1. Transit Instrument—The instrument in use is of 2in. aperture, and 22½in. focal length ; it has none of the usual accessories of modern transit instruments, such as micrometer, tangent screw for sideway motion of the eyepiece, reversing apparatus, etc., which greatly facilitate and add to the excellence and accuracy of the observations obtained ; still, in the hands of a careful observer no doubt an accuracy sufficient for the purpose required, viz., the rating of chronometers, is obtained. Mr. Kingsmill has lately caused to be added a Bohenbergen eyepiece and amalgamated mercury trough ; this has greatly facilitated the speedy and correct adjustment for collimation and level. The amalgamated form of mercury trough is especially essential on account of the vibration set up by the trams, which pass on either side of the Observatory at a distance of under quarter mile on an average of four times every quarter of an hour. 2. Clocks.—There are two clocks—one, a sidereal in the transit hut, is exposed to every variation of temperature, and in consequence has an ever-fluctuating rate ; the other, a mean solar clock in the Observatory building, has to be corrected every day at noon to exact mean time for dropping the ball, and can therefore be said to have no known rate. Consequently in the event of cloudy weather no dependence can be placed on either of them, and the time is regulated by a single box chronometer kept in the Observatory building. At present there are no ready means of accurately comparing the clock in the transit hut used for observation with either the chronometer or the mean solar clock. At small expense a clock face might be fitted close to the mean solar clock electrically connected with the sidereal clock, affording a simple and extremely accurate method of comparison between the two. This is the method usually employed in all observatories. A good standard clock is much needed ; this could be placed in the cellar for the sake of uniformity of temperature, and electrically connected as above with the room in which is the mean solar clock. 3. Error in Position of the Meridian Mark on Mount Nelson.—In order to obtain this the distance of the meridian mark from the transit instrument was first ascertained by triangulating between the two, using certain data obtained from a local triangulation by Mr. Mault, for a base line. This distance was found to be 6,479ft. A wooden scale was then erected horizontally across the meridian mark, and graduated in arc so as to form a distant micrometer when viewed through the telescope of the transit instrument ; this enabled the azimuth error, as found by observation, to be actually shown in lineal distance at the meridian mark. Observations were made as opportunities offered on various nights of pairs of stars differing considerably in declination, of polar stars and pairs of circumpolar stars at opposite culminations, with the resulting mean deviation of 64″ of arc, showing the present position of the meridian mark to be 2ft. to the westward of the true meridian. This corresponds very nearly with the error that Mr. Kingsmill had previously estimated and allowed for. The probable error of the observations by the method of the least squares is + − 2″6 ; this corresponds to a lateral distance of + − 1in. at a distance of 6,479ft. The meridian mark in its present position is quite useless for the purpose intended, and I would suggest that it be moved 2ft. eastwards into the true meridian, and also that there be cut in on the face of the stone, in addition to the present × in circle, a few micrometer teeth on either side, exactly similar to the marking of the present temporary wooden scale. This would enable the residual small errors in azimuth of the transit telescope to be at any time during daylight read off in seconds of arc and allowed for in the usual manner, instead of the frequent injurious alterations of the adjusting screws of the instrument. 4. I would further wish to point out that, although when this alteration is effected, the time by the transit instrument will be obtained with all the accuracy necessary for the purpose, yet that the present means of communicating it to the shipping in port by means of the time ball are quite inadequate and liable to error. Signals are sent from the Observatory to the signalman at the flagstaff, Fort Mulgrave, where the time-ball is situated, by electricity during the last minute previous to 1 p.m. The electrical fittings are so inferior that they frequently break down entirely for days together. Mr. Ellery, the Government Astronomer at Melbourne, whilst recently in Hobart gave as his opinion that this might be remedied by a very simple alteration. Again, the ball is hoisted by a rope and winch, and in order for the ball to appear to drop at 1 p.m. it is necessary for the signalman to let go the winch handle a certain time beforehand; this he does when he sees the last time signal at 2sec. to 1 p.m., he actually lets go about 1sec. to 1 p.m., and the ball itself drops about half a second past 1 o'clock; by dint of long practice and habit this error is fairly constant, and varies from 0·5sec. to 0·8sec. too late, but it is obvious that the error is liable to variation, and that under the circumstances it is absolutely impossible for the man to drop the ball exactly at 1 p.m. This, I think, might be obviated by some simple automatic method of dropping it, to work with the assistance of a relay by the same electric current from the Observatory as works the time signal. It would be a good plan in future when the time-ball fails in accuracy to hoist it again immediately half-mast, close up at 1·55, and drop it in the usual manner at 2 p.m., publishing the error in the next morning's paper. This is the usual method adopted in many ports in similar cases. 5. Lists of Stars.—The Nautical Almanac is quite inadequate for transit work, especially in south latitudes, by reason of the small number of stars, and especially South Polar stars, for which the apparent places are given. It is seldom or never used, even at the Royal Observatory, Greenwich, the French "Connaissance des Temps," published annually, price 4f. 75c., being much preferable; *e.g.*, in the "N.A." the App. places of 224 time stars are given, and one South Polar star; in the "Connaissance" the App. places of 360 time stars, and 11 South Polar stars. I would suggest that this work be added to the Observatory Library. 6. Geographical Position.—The position of the transit instrument has been calculated from that of the transit pier in the Barrack-reserve, used by the U.S. Transit of Venus Expedition in 1874. As this latter stone is the standard of longitude for Tasmania, I would suggest that a permanent record be cut on it giving the exact latitude and longitude. These are furnished by the Melbourne Observatory, viz., lat. 42·53 deg. 24min. 6sec.; long. 147·19deg. 57min. E. I have the honour to be, sir, your obedient servant, Herbert E. Pury-Cust, Lieutenant and Commander."

That is the report, and the colony owes a debt of gratitude to Captain Cust in providing us with it, and for which the colony did not spend one penny.

Mr. MAULT urged that the great utility of the work done at the Observatory would be enhanced if the Government would add to the establishment some magnetic instruments.

Mr. E. A. **Counsel** interestingly reviewed the development of time-keeping, and pointed out the great consequence correct time was now in these days of quick communication, and the disastrous results likely to follow to life and commerce in places where railway facilities were numerous if correct time were not maintained.

The **Chairman** followed the previous speakers in praise of Commander Cust's work, and hoped that the colony would be long supplied with Mr. Kingsmill's observations. With the assistance of the Leake bequest he hoped that the Observatory would be made one of the permanent attractions of the City of Hobart. Although the present was not a propitious time to approach the Government for assistance, still he thought the Royal Society would help in securing the modest additions necessary to enable the work to be done more accurately.

Mr. **Kingsmill** referred to the difficulties experienced with the present arrangements for working the time-ball and gun. The electrical method was the most perfect, and as the use of the current would be but momentary, he suggested that arrangements might be made with the Tramway Company for utilising their powerful current to work the ball and fire the gun simultaneously. (Applause.)

The **Chairman** thought that there would be no difficulty in securing such an arrangement.

A NEW EUCALYPTUS.

Mr. L. **Rodway** read some botanical notes on new and rare plants, the chief interest centering on a further description of a eucalyptus (described in 1886 by Mr. T. B. Moore, and named *Eucalyptus müelleri*, after Baron von Müeller), from specimens found on the southern slope of Mount Wellington, just below the Springs, where the tree attains a height of 200ft. and more. With regard to the timber he said—"The wood is of a pale red colour, and rather heavy; of a close fibrous texture, of great tenacity, and is commonly used for palings and shingles, but it makes excellent axe handles, and would be very useful for all purposes where considerable strength and toughness are required.

A CORRESPONDENT LOST.

The **Secretary** read a letter from Baron von Müeller, stating that some gentleman in Launceston had asked him for his opinion regarding the reservation of several acres of public land for preservation in its pristine beauty. The answer was delayed, the Baron wishing to send a book with the reply. When the book was obtained, the letter containing the name and address of the correspondent could not be found. The Baron now forwarded the book to the Secretary of the Royal Society to hand to his correspondent if discovered.

JULY.

The monthly evening meeting of the Royal Society of Tasmania was held at the Museum on Tuesday evening. Mr. James Barnard occupied the chair. Apologies for absence were received from the President (Viscount Gormanston) and the Hon. Sir J. W. Agnew.

TASMANIAN TIMBERS — THEIR COMMERCIAL USES AND PREPARATION FOR MARKET.

Mr. A. Osborn Green read a practical paper on this subject. He stated that last year Tasmania's timber exports were valued at £18,000, the imports at £9,000, and the excess of exports over imports for the past five years was £66,000. Norway, a poor and sparsely inhabited country, with no trees that would cut 12in. planks, exported every year timber valued at several millions sterling. Tasmania was covered with trees, some of which would singly furnish sufficient timber to build a ship; trees furnishing timber for every industrial purpose, comparing favourably with any for keeping in truth, durability, hardness or softness, heaviness or lightness, beauty of marking, and fragrance. Notwithstanding this Tasmanian timber exports were nominal, the woods not being merely unknown in the world's markets, but the majority were only known as curiosities in the city of Hobart itself. A buyer would have difficulty in placing an order for them. Out of the 10 eucalypti of the island 6 were not obtainable in plank. But it was gratifying that our timber imports were yearly falling off, and it should be the endeavour of every one with the interests of Tasmania at heart to bring her valuable timbers into more general use locally, and by the diffusion of more exact knowledge to bring about such an export trade as would for ever assure the colony a large and certain revenue. He submitted a complete list of Tasmanian timber trees. These would supply timber for every industrial purpose for which timber was used. It was said that "common hardwood" was not to be depended upon. The faults were not of the timber, but attributable to distinct kinds of trees, cut in and out of season, being promiscuously bundled together under the name of "gum" or "hardwood" timber, to the want of classification, and to the use of unseasoned timber where only seasoned should have been used; or, where unseasoned timber was admissible, using it without proper provision for the shrinkage which must occur. Suppliers and users must recognise the necessity for treating timbers like men—timbers must be classified and put to the work for which they were best suited. It was a hopeful sign that a large cargo of named eucalyptus had been sent to London, profitably sold, and a second cargo was being prepared. Sawmill owners and timber merchants had prayed for an independent inspection before the timber was shipped, and were diligently seeking how to assure a continuation of orders and further expansion of business. The necessity for inspection was shown by the fact that some lots were not allowed to be shipped, and chiefly owing to the appointment of an independent inspector the shipment had been described as undoubtedly the best that had ever been sent from Hobart. This was satisfactory, but it was only once. The inspector was only appointed temporarily, and his duties then only extended to keeping out bad timber. The timber was only to be used for the commonest purpose, for paving roadways, and coming into competition with the cheapest timber placed upon the London market—yellow deal in short lengths. Not that yellow deal was by any means to be despised, for it was of a durable nature, and the people supplying it graded and classified it as a matter of course. Therefore, if our exporters hoped to keep the footing already obtained they must not dream of relaxing a jot of the conditions by means of which that foothold was obtained. One mixed or inferior shipment would have a most damaging effect; might, indeed, put Tasmania out of the market for a generation, for no man had such a long memory as a deceived business man. The intrinsic merits of Tasmanian timber would shortly win for it a position in the home markets if they were not clouded and hidden by the ignorance and carelessness, or worse, of millers and exporters. Let millers either ring or fell at the right season, classify their logs, honestly grade their planks, and beyond this not only submit to but court and demand the most rigid independent inspection and marking—then not only would the Derwent from New Norfolk to the sea be thickly dotted with vessels bringing timber to regular lines of ships crowding the wharves of Hobart, but the sound of the axe and the hum of the saw would be heard throughout the island. A vast opening existed for our timbers in England, France, Spain, Portugal, Italy, and the Cape. He described in detail the method of preparing for market Baltic deals, the wood at present in competition with Tasmanian hardwood for paving blocks. The trees were felled when the sap was down, and they were sorted for size; butt lengths of large trees were set apart for first quality, small butts for second, and tops for third and fourth qualities. On being sawn, the planks were again examined and sorted before leaving the mill. At the port of shipment the timber was closely examined for size, cutting, and quality, the deals going forth to the world as first, second, third, or fourth quality, according to the classification adopted at the particular port of shipment. In Norway and Sweden numerous marks were used to denote each quality, so that the London builder finding "Jansen's" cutting suitable, naturally inquired for his trade mark when next in the market. Builders did not use deals promiscuously, but chose one mark for framing doors, another for studding, house and warehouse floors, each having marks considered most suitable. At other Baltic ports, sworn officers marked timber and other produce as first, second, and inferior. Unmerchantable qualities were not allowed to be exported to bring the port into discredit in distant lands. These marks were so well and faithfully applied that merchants would buy on the mark alone, and the value of the marked timber was as well established as the price of gold. By the lettering of the mark the purchaser could pick out stacks coming from particular districts near certain ports of shipment, having found by experience that the timber wanted was there produced. Satisfying himself by inspection that the standard of excellence he had so long known was still maintained, he went with confidence either to make an offer for the shipment or to bid for lots at the next auction. Not a deal, plank, or batten was sent to market without being plainly branded on the end with marks denoting where it came from, and its quality. The European exporter knew that only by the strictest honesty of classification could he gain the confidence of the market and full prices. In these days of keen competition the difference of a small percentage in the selling price meant the difference between an assured competence and ruin. At present England was looking for new sources of timber supply. Australasia was anxiously seeking an outlet for her superabundant resources. To retain her advantage, he suggested that Tasmania should see:—"(1) That all timber be rung or felled when the sap is down. (2) One colour should be chosen for branding Tasmanian timber. (3) That every millowner register a set of marks, a separate mark for each quality of each timber that he saws, and mark each piece that leaves his mill, it being more important to mark bad qualities 'bad' than good ones 'good.' (4) That all registered marks be properly protected. (5) To collect and make public the fullest information concerning the marks and qualities of our timbers generally, giving equal prominence to the merits and defects of both the species of timber, and of the same timber from different localities, pointing out details by which the quality may be judged, in fact placing the whole of the local knowledge freely at the service of inquirers. (6) At the outset to allow nothing to be sent to Europe but first quality timber, and to prevent second quality being sent until there was an inquiry for it. (7) That an independent authority shall verify all marks before timber is allowed to be exported, and place an official mark upon each piece. (8) If the timber were picked and marked for certain uses, *e.g.*, paving, framing, floors, implements, tool handles, etc., it would be an advantage." The classification mentioned was necessary for any timber, and for eucalyptus perhaps more than any other in the world. With such a system of classification, with millers ready to supply any quantity at short notice, and exporters able to supply seasoned or fresh timber, a great deal necessary to ensure success would have been achieved. But to complete the scheme it would be necessary to have an energetic, well-educated business man, well up in the qualities and uses of timbers, with samples portable and in bulk, in the rough and in finished articles, whose business it should be to drive home to users the advantages of our timbers. Tasmania must be satisfied with no half measures if she wished to compete with her neighbours, to introduce a new material into the markets of England and to change the trade customs of one of the most conservative of countries.

A number of specimens of timber were shown by Mr. Green to illustrate the superiority of Tasmanian woods, and the reading of his paper evoked loud applause, subsequent speakers, including Hon. C. H. Grant, M.L.C., Messrs. T. Stephens, M.A., F.G.S., A. Montgomery, and Morton, endorsing generally its contents.

OTHER PAPERS.

Mr. JAMES R. McCLYMONT, M.A., contributed an interesting paper on "Ancient wrecks and relics of European vessels on Australian coasts." The writer dealt with wrecks belonging to the seventeenth century, and treated his subject chronologically and topographically.

Mr. L. RODWAY described "A New Centrolepis," of the order Centrolepidiæ, seldom honoured with attention by any but the inveterate collector or the botanical student.

The customary votes of thanks were passed, on the motion of the CHAIRMAN, who mentioned the probability of the Council considering the timber question one of sufficient importance for a renewal of the discussion at the next meeting.

AUGUST.

The usual monthly meeting was held on Tuesday. There was a fair attendance of Fellows, and a few ladies. The chair was taken by Mr. T. Stephens, M.A., F.G.S. The Hon. Sir Jas. Wilson Agnew, K.C.M.G., M.D., M.E.C., and Mr. Jas. Barnard wrote apologising for their absence.

The Secretary, Mr. A. MORTON, read a circular from Mr. Shirley, secretary to the Australasian Association for the Advancement of Science, which meets at Brisbane on January 11, 1895, and following days, soliciting the assistance of Fellows in making the meeting a success, and promising them a cordial reception. Railway and steamboat fares would be reduced to visitors. Mr. Morton stated that Professor McAulay and Mr. Fincham, Engineer-in-Chief, would read papers at the Brisbane meeting.

Mr. Robert Henry was unfortunately detained by heavy weather in the Straits Islands, consequently the reading of his paper "On a new method of dropping the time ball" was postponed.

GLACIATION ON THE WEST COAST.

Mr. MORTON, on behalf of Mr. T. B. Moore, read a paper on "Further discoveries of glaciation in Tasmania." The paper was lengthy, but most interesting. The writer commented on papers read by himself and other Fellows on the same subject at previous meetings of the Society. A number of specimens of rocks subjected to glacial action accompanied the paper, and were used to illustrate the writer's observations.

The CHAIRMAN briefly reviewed the paper, and explained the difference between conglomerates and morains, and their probable origin.

THE PROTECTION OF MUTTON BIRDS AND SEALS.

Bishop MONTGOMERY read the following paper :—

In the course of my annual trips to the Furneaux Islands I have obtained information from those whose knowledge of the habits of the sooty petrel can be relied upon, and I beg now to lay before the Society some further results based upon personal observation and on inquiries among the half-castes, in order to supplement what I read on a previous occasion on the same subject. The following is an accurate statement of that wonderful rush of these birds to their breeding places every evening till the whole colony takes its departure. On Goose Island, evening after evening, I ensconced myself under a rock for five days, noting every indication of the habits of these birds. The sooty petrel returns to its hole in silence, except in the case of a few belated individuals, who indulge in a hoarse cackle as they fly to and fro, apparently unable to find their holes at once when the night is very dark. On one occasion I took up a position, watch in hand, on a rising ground, from which I could overlook the whole rookery, as well as the sea on both sides of the island. It was in the month of February. At 6 35 p.m. not a petrel was to be seen anywhere, though I could see for miles on all sides. At 6.40 the first bird came into view. At 6.43 the sun disappeared ; 6 48, sunset from the top of the lighthouse and the light flashed out ; Cape Barren geese heard in the distance settling for the night. 6 53, the first petrel flew rapidly over the island without settling. 6.56, the numbers so great that I stopped counting, unable to do so. 6.58, the birds now so numerous that their flight was bewildering. 7.6, the numbers at their maximum. 7.30, nearly all the birds had arrived, and now the underground noises were most extraordinary, as oil was being poured down the throats of tens of thousands of young birds, apparently to their intense satisfaction after their 24 hours' fast. I desire also to place on record the following fuller statement of the sooty petrel at an earlier period of its annual sojourn amongst us. I believe the facts can be relied upon as correct. In September mutton birds come back to us to dig their holes. Where they have been since the previous May no one seems to know with certainty. I have interrogated captains of many ships whether they have ever been seen by them in these winter months. In all cases they have replied in the negative. And it seems we are forced to the conclusion that they betake themselves towards the South Pole. After digging their holes they vanish for about a fortnight, after that they reappear to lay their eggs. The female soon loses her condition and betakes herself to the sea for about a week, not returning during the interval. Meanwhile the male bird sits upon the egg, and he in turn is relieved by the female in order to recover his condition. The egg is hatched in about five weeks. When the young bird appears both parents return every evening to feed their offspring. For most of the time the birds desert the vicinity of their breeding places during the day, but in the Furneaux Islands during the prevalence of easterly and south-easterly weather the parent birds keep near home, the reason being, as is supposed, that this wind brings them especially large quantities of their food. It was remarked to me also by some of the most experienced hands that after a continuance of south-easterly weather they always expect to obtain a larger quantity of oil from the birds. When the young bird is taken and killed he is carefully spitted on a stick and kept head upwards till about 50 are obtained, when the worker squeezes the oil from them, and sends them away to be plucked and salted. Every year one or two white specimens of this bird are seen. I am doing my utmost to obtain one for this museum. To turn now to the practical working of the Act passed some two years ago for the protection of the mutton bird industry, there is no doubt at all that the provisions of the Act have been most beneficial, and, practically speaking, if the regulations are fairly carried out, the petrels will never leave these islands, nor will they diminish in numbers. There are a few points, however which deserve the attention of our legislators. At present there is no restriction placed on the number of persons permitted to bird on any island; some day trouble may arise. It is certain that if the number of workers were doubled the industry would be endangered. Secondly, there is a feeling among some of those engaged in the industry that the old birds should be protected, certainly while they are feeding their young, possibly whilst they are hatching their eggs. At present they may be taken at either period for consumption on the spot. Certainly to leave the young bird to die of starvation is contrary to the dictates of humanity. It might be wise to make a regulation that no old birds were to be taken after a fixed day in January. This would prevent the death by starvation of young petrels.

THE SEALING INDUSTRY.

As the seal rocks are now to be thrown open once more to sealers after a close time of about three years, it may be of interest to the Society if I lay before its members the suggestions made by sealers and others for the protection of the industry. Mr. Maclaine, of Clarke Island, advocates the protection of female seals altogether, following the law that obtains in the Behring Straits. On the other hand, the most thoughtful of the sealers themselves assert that this would virtually stop sealing, inasmuch as the female seal is much more numerous on the rocks than the male; but whether this last assertion is true I am not in a position to say. But whilst these men do not wish to be altogether debarred from killing female seals, they view with abhorrence the destruction of the females whilst their young are dependent upon them. More than one of them has described how heartrending are the cries of the little seal left to starve on the rocks before it can take to the water. These people advocate a close time for seals every year, namely, the period when the pups are being suckled and before they take to the water. The time they suggest is November, December, and half January. This is the season when the seals are easily killed, since they will not leave their young. Before the young seals are born, apparently, the females can take very good care of themselves. The Tasmanian sealers look with apprehension also upon the advent of vessels from New Zealand. They tell a story (I give it as I heard it) that the crew of one of these foreign vessels once succeeded in extending a strong rope net of some sort round a rock and then proceeded to kill everything upon it. The story at least points to some very complete system of destruction put in operation by these energetic foreigners. Without doubt we have arrived at a critical epoch in the history of our seals. They are once again extremely abundant, and wise regulations, framed without loss of time, may save an interesting inhabitant of our seas and protect a valuable industry as well.

Mr. **Bernard Shaw** stated that the mutton birds are protected by existing regulations all the year round, excepting from March to May. The proposal now is to protect the young birds and stop the destruction of the eggs. This will be met by the new regulations. Birds sitting and feeding their young must also not be taken. With regard to seals, the regulations which have been in existence since 1891 expired on July 25th. The Commissioners of Fisheries have not yet been able to bring the new regulations into force, but he hoped that when they were in force they would be in operation for a long time. Fur seals only were protected, and of those the females were entirely protected, as were the young under 10 months. The regulations would be made to apply to Macquarie Island, so as to strengthen the hands of the New Zealand Government, who protected seals in their own waters, and when they discovered skins suspected to be "poached" they were told the seals were captured on Macquarie Island.

Mr. A. **Morton** also spoke on the subject, and pointed out that the Tasmanian fur seal, though not so valuable as the Alaska species, was the true fur seal of commerce. There was no reason why the seals should not return in the great numbers of early days so soon as they were protected. The sealer had no better friend than Mr. Bernard Shaw, while the industry itself could be developed into a very important one. It should not be overlooked that the protection of the seal was helping the half-caste.

ADDITIONS TO THE MUSEUM.

Mr. **Morton** laid on the table a number of interesting curios sent by Rev. John Chalmers from New Guinea and the Fly River district, which included a drum, bone daggers, stone axes, and other articles. A very fine pair of horns of an Indian bison, presented and shot by Colonel Cox, was also inspected by the Fellows. Colonel Cox gave some interesting particulars of the animal under discussion, and stated that its habitat was in the Sheveroy Hills, Madras Presidency, where he had shot similar animals, and bagged one of the best pair of horns ever taken in India.

The proceedings concluded with votes of thanks to the readers of papers, the donors of the additions to the Museum, and the Chairman.

SEPTEMBER.

The monthly evening meeting of the Royal Society of Tasmania was held at the Society's room, Museum, on Tuesday, September 12th. Hon. C. H. Grant presided, and there was a good attendance. Apologies were received from the Hon. Sir Jas. Wilson Agnew, K.C.M G., M.D., M.E.C., and Mr. Jas. Barnard, Vice-Presidents.

PROTECTION OF NATIVE FAUNA.

A letter was received through the Premier (Sir Edward Braddon) from the Australasian Association for the Advancement of Science, Adelaide, enclosing the report of the committee appointed to make recommendations for the protection of native fauna, and asking that Tasmania would assist in carrying out the recommendations of this committee. Among other suggestions, the report urged that the Schouten Main (Freycinet Peninsula) should be set aside as a national park for Tasmania, that the Victorian and Tasmanian Governments should be requested to draw up a joint Act for the protection of the Cape Barren goose on those islands on which it is found in Bass Straits; that existing game laws should be strictly enforced, and that in all Game Acts provision should be made for the proclamation of districts, comprising both Crown lands and private property, wherein particular species may be absolutely protected for indefinite periods.

The SECRETARY (Mr. A. Morton) said that this communication and report had been submitted to Mr. Bernard Shaw, who had dealt with the points raised. Concerning the recommendation that Freycinet Peninsula and Schouten Island should be used as a national park he (Mr. Shaw) had received opinion from Mr. John Meredith, of Cambria, Glamorgan, who considered that while the Peninsula was unsuitable for a national park, owing to its geological formation, etc., Schouten Island would be a suitable spot. With regard to the protection of the Cape Barren goose and the mutton bird, these birds were already protected by Acts of Parliament in Tasmania, and the inhabitants of the islands were generally credited with obedience to the provisions of the game laws, and the constable stationed there exercised supervision over them. The suggested provision for absolute protection of certain species by proclamation for indefinite periods already existed in Tasmania as regarded native game birds, but not as regarded animals.

Bishop MONTGOMERY said that there were a great many mutton birds in the Straits, and not long ago he had seen a large number of Cape Barren geese there. On the whole, although some instances of ruthless slaughter occurred, the Cape Barren geese were being well protected. He favoured Cape Portland as a place where the native fauna of the colony could be preserved.

Mr. MORTON complained that although there were close seasons certain birds ran a risk of being exterminated by their wanton slaughter by so-called sportsmen.

The CHAIRMAN considered that the birds of the island were very well protected. As regarded the animals, he did not see how they could be preserved in a park unless of a very large area, as some of them preyed on others. However, it would be as well to keep the matter before them, and if an opportunity occurred they might obtain land for a national park.

PROTECTION OF THE FUR SEAL.

The SECRETARY, after apologising for the absence of the president of the Fisheries Board (Mr. M. Seal), introduced the matter of the protection of the fur seal in Bass Straits and Macquarie Island, and said that the Government of Tasmania had unfortunately decided that there should be no close season for these animals.

Bishop MONTGOMERY was sorry that the Government should have arrived at such a conclusion, for unquestionably if there were no close season there would not be a seal left in two years time. On the score of humanity and for the preservation of the sealing trade, some protection was necessary. The islanders were in favour of a close season of about 10 weeks. He moved,—"That the following be a deputation to wait on the Chief Secretary *re* the protection of the fur seal:—Sir J. W. Agnew; Messrs. C. H. Grant, M. Seal, A. G. Webster, Curzon Allport, and the mover."

Mr. F. J. SALIER seconded, and the motion was agreed to.

ORTHOGRAPHY OF GEOGRAPHICAL NAMES.

Mr. T. STEPHENS drew attention to a circular which the Government had received from the Royal Geographical Society of England on the orthography of geographical names. The circular advocated the adoption of a system of orthography for place names which would be simple enough for any educated person to master with the minimum of trouble, and which would at the same time afford an approximation to the sound of a place-name such as a native might recognise. No attempt would be made to change names which had acquired an established standing, but it was considered that in new names it would be better for the appearance of the words to give some idea of the pronunciation. As far as Tasmania was concerned, very little attempt had been made in the early days to preserve the native names, and the few there were seemed to have been selected at haphazard from a vocabulary without reference to their suitability to the places to which they were applied. He believed, however, that the Lands Department had taken some pains to make a collection of native names which would be applied to new places which might arise. He thought it would be as well for the Society to assist in every possible manner the object of the Royal Geographical Society, and moved,—"That a committee be appointed to consider and report on the circular issued by the Royal Geographical Society of England as follows:—Sir J. W. Agnew; Messrs. J. B. Walker, C. H. Grant, Bernard Shaw, and the mover, with power to add to their number."

Mr. B. SHAW seconded, and the motion was agreed to.

VOYAGES TO PAPUA.

Mr. J. R. McCLYMONT, M.A., read a paper on "Early voyages to Papua, 1511 to 1545," which he illustrated by references to a map of the world and other charts. The paper treated the subject exhaustively, and was closely listened to.

Owing to the lateness of the hour, Mr. Robert Henry's paper on a new method of dropping the time ball was postponed till the next meeting of the Society.

The CHAIRMAN having briefly thanked Mr. McClymont for his paper and gentlemen for their remarks, the meeting closed.

OCTOBER.

There was a large attendance of Fellows and visitors at the Royal Society meeting held on Tuesday, October 9th, in the Art Gallery, under the presidency of Sir Lambert Dobson. Apologies for absence were read from His Excellency the Governor, Hon. Sir James Wilson Agnew, K.C.M.G., M.D., M.E.C., and Mr. James Barnard. Messrs. B. T. Solly and L. Cookhead were elected Fellows.

A NEW METHOD OF DROPPING THE TIME BALL.

Mr. ROBERT HENRY, in reading a paper on "A new method of dropping the time ball," referred briefly to the existing means for letting Hobart know when it is supposed to be 1 o'clock. In his opinion, provided the arrangements were all in good working order, the present method should be effective. But to ensure absolute accuracy it was desirable that the process should be automatic as far as possible, and with this object in view he submitted a scheme for dropping the ball, and also firing the gun electrically. He described the details, and acknowledged indebtedness to Captain Parker, R.N., for the idea as to the manner for releasing the time ball. Various other appliances were in use, but this should commend itself for simplicity and inexpensiveness. The present mode of signalling the time throughout the colony gave all that was desired, and should not be disturbed, but the time ball arrangements should be separate and distinct. It would be more advantageous to use a special clock for the signalling instead of doing it by hand. Mr. Henry concluded his paper by conducting an interesting experiment, which consisted of firing a toy gun and dropping a model time ball by electricity, the Chairman applying the current.

Mr. KINGSMILL (Government Meteorologist) said that something more important than signalling was to first of all get the right time. Supposing the ball to be dropped and the gun fired electrically, if there was an error it would be brought home to him. There could be no third party. But he thought he was at liberty to mention that ere long there would be, through the generosity of a citizen, a better means of obtaining correct time than at present. Mr. David Barclay had very kindly placed his clock, known to be the best in the Southern Hemisphere, at disposal to be connected electrically with the Observatory. With liberty to read Mr. Barclay's clock alongside the present instrument in cloudy weather, when it was often and for lengthy periods impossible to take observations, a better standard of time might be looked for in the future. When this was done he would not be afraid to see electric signalling established.

PRIMITIVE THEORIES OF POLITICAL TEACHING.

Dr. W. JETHRO-BROWN, M.A., LL.D., read a paper on "Primitive Theories of Political Teaching," in which he attempted to answer the questions of what was the earliest theory of political duty, and at what stage in tribal history was the theory evolved?

Mr. MAULT and Rev. Dr. SCOTT expressed surprise that in his paper Dr. Jethro-Brown had not mentioned the patriarchal origin of authority.

Dr. JETHRO-BROWN, in reply, said that the point was one that had been very elaborately discussed in a large number of works. At present, so far as investigations went, the patriarchal theory, as far as the Aryan races were concerned, was better than any other advanced. But we must distinguish between theories of the origin of society and theories of the origin of political duty. Until we got beyond the family we could not have the idea of political duty.

THE HARTZ MOUNTAINS.

Mr. J. W. **Beattie** read some "Notes on a recent trip to the Hartz Mountains," descriptive of a photographic tour through the bush from Geeveston to the summit of the mountains. The paper was elaborately illustrated by lantern slides, manipulated by Mr. Nat Oldham, and the audience was given an excellent, interesting, and general idea of the scenery, lake and mountain, bush and plain. Mr. Beattie considered that the Hartz Mountains were likely to become popular as a tourist resort for three reasons: (1) They are easily accessible; (2) every mile of the route from Hobart to the mountains is full of interest and beauty; (3) they comprehend every phase of tourist enjoyment.

Mr. R. M. **Johnston** proposed a vote of thanks to Mr. Beattie, whom he thought had done more than anybody else to give the world an idea of the beautiful scenery of Tasmania.

Hon. **Henry Dobson**, M.H.A., supported the motion, and suggested that Mr. Beattie should deliver his paper as a lecture again in the summer when the city is full of visitors.

The vote of thanks was extended to the readers of other papers and to Mr. Oldham, and carried with acclamation.

1895.

MAY.

The first meeting of the 1895 session of the Royal Society of Tasmania was held in the Art Gallery, Museum, on Tuesday, May 20th. There was a very large attendance, Sir James Agnew occupying the chair in the absence of His Excellency the Governor, who had a prior engagement.

PAPERS.

The following papers were taken as read:—

"NOTES ON A MINERAL SUBSTANCE NEW TO TASMANIA," by Mr. W. F. Petterd:—During a recent visit to the Zeehan silver-field my attention was drawn to a peculiarly coloured and unusual form of pyrites occurring in one of the silver-lead lodes on the property of the Silver Queen Prospecting Association. It is found in some quantity, both massive and disseminated, closely associated with various other forms of pyrites and richly argentiferous galena in a portion of this particular lode, locally known as "Clarke's Tribute." In colour it is of an unusual greenish grey with a bronze-like highly metallic lustre, but is sometimes inclined to brass yellow from extreme admixture of chalcopyrite. It is very brittle, with an uneven fracture. Its hardness is about 4, of the scale; specific gravity, 4·5. Upon a qualitative analysis by the wet process, and examination with the blowpipe, the substance proves to be a rare mineral known as stannite (a sulpho-stannate of iron and copper), or chemically, $2\ \mathrm{Fe}, \mathrm{Sn}\ \mathrm{S}_2 + 2\ \mathrm{Cu}\ \mathrm{S}, \mathrm{Sn}\ \mathrm{S}_2$=S29·77; Cu 29·77, Sn 27·44, Fe 13·02=100. The mineral is commonly known as "tin prites," or "bell-metal ore," and is almost peculiar to the stanniferous districts of Cornwall, England, being only rarely found out of its original locality. It has been reported to occur in Bohemia, at Zinnwald, in the Erzgebirge, with blende and galena. In Australia it is reported to occur in extremely limited quantity in the tin districts of New South Wales and Northern Queensland. The finding of this mineral in association with silver-lead is quite unexpected, and very interesting from a scientific point of view, more especially as it is in itself of a high argentiferous value, which is quite a new feature with this chemical compound. I am informed by Mr. J. G. S. Stitt, of Zeehan, that its average silver value is about 90oz. per ton, and that it is readily purchased—mixed with other minerals—by the local ore-buyers. Numerous analyses of stannite from Zinnwald and Cornwall give a metallic tin value of from 25·81 to 31·62 per cent., the copper varying from 23·55 to 30·0, but I am not prepared with information as to the metallurgical value of either metallic constituent as occurring in chemical association. I have submitted samples to Professor G. H. F. Ulrich, of the Dunedin University, who writes, under date March 30, 1895:—"The sample of ore is stannite, or bell metal ore, as you supposed. Our lecturer in metallurgy and assaying, Mr. Fitzgerald, made a rough quantitative analysis of the ore, the results of which fall also within the range of the analysis given for stannite in Dana's 'System of Mineralogy.' Its colour, streak, hardness, and indistinct cortical cleavage are also in agreement with those given for the mineral. If the ore occurs in any quantity the respective mine owners would, I think, be wise in getting it picked out for separate sale, with the object of having its contents in copper and tin taken into account in the sale price in addition to the per cent. of silver.' The sample sent with this note is one of many collected by Mr. Stitt and myself from the ore heap at the locality mentioned. Will you please add this to the Museum collection.

"NOTES ON FURTHER PROOFS OF GLACIATION AT LOW LEVELS," BY MR. T. B. MOORE, F.R.G.S.—After referring to an extract from a letter to himself from Professor R. V. Lendenfeld, of the University Czernowitz, relative to and agreeing with a previous paper on the first proofs of land glaciations in Tasmania, the writer said that upon examination of the banks of the King River, West Coast of Tasmania, he had discovered large ice worn boulders, striated and grooved, in the deep gorge of the river situated at the upper landing, and also similar glaciated boulders in Harvey's Creek, at a distance of a quarter of a mile from its junction with the King River at the landing. The boulders were large, many tons in weight, and composed principally of silurian sandstone, and the distinctness of the planed surfaces, grooves, and striæ was a conclusive proof that the period of the transposition by the ice was of very recent (comparatively) date. These blocks were at an altitude of not more than 100ft. above the sea level. In the same locality, on the southern bank of the river, 150ft. above its bed, was a large moraine, composed of rocks brought from the inland mountains, probably at the beginning of our glacial period. During the recent substantial improvements to the Strahan-Lyell-road, a very interesting phenomenon of the glacial action had been exposed through the accumulation of rubbish and moss being removed from the cuttings and drains of the road. A full description of this phenomenon was given, and as it was accessible on the way to the greatest mine in the Island, which many scientists and geologists were sure to visit, it was to be hoped that more able men than the writer would give their views as to its age, origin, and nature. Illustrative specimens from this last discovery were exhibited.

"Notes on some new fossil plants to Tasmania," by Mr. R. M. Johnston, F.L.S., and "The Botany of the Hartz and Adamson Ranges," by Mr. L. Rodway.

AUGUST.

The usual monthly meeting was held on Tuesday, August 10th, Mr. T. Stephens, M.A., F.G.S., Vice-President, in the chair.

The SECRETARY (Mr. Morton) read apologies from Sir James Agnew Colonel Legge, and Messrs. James Barnard and A. G. Webster.

ORIGINAL RESEARCHES.

The SECRETARY read a communication from the Royal Society, New South Wales, offering its medal and £25 for the best communication containing results of original research or observations upon scientific subjects, to be sent in by May 1, 1896, and May 1, 1897.

TIMBER FOUND BENEATH ALLUVIAL DRIFT.

The SECRETARY read a paper by Colonel Legge, R.A., on "Timber found beneath Alluvial Drift at Swansea," abridged as follows:—Driving from Bicheno to Swansea travellers crossing the Lyne Sugar Loaf Range come suddenly in view of the large level tract of country lying south of the hills stretching from Cranbrook towards the ranges bounding St. Paul Valley on the east. This tract is mainly formed by the coast range, from St. Patrick Head to Bicheno, suddenly swerving inland at the latter place, and joining the highlands east of St. Paul, lying some distance from the East Coast. About Swansea the ranges approach the coast again, following the shore southwards. The country thus hemmed in is alluvial, forming what may be styled the basin of the Swan River, the Cygnet, and the Wye. On existing maps these mountain features scarcely appear. The surface of this basin is mostly level, with occasional gentle rises of about 100ft. The soil is chiefly dark chocolate, apparently the result of denudation and drift from the extensive valleys on the highlands at the back. On the Cambria estate, lying mainly at the foot of the "Lookout," locally the soil is rich and deep; and on that portion between the main road and Oyster Bay is an extensive lagoon, which seems in former times to have joined the Meredith River by an extinct watercourse, visible in the form of a sinuous depression, on the course of which a deep dyke has recently been cut by Mr. Meredith to drain the lagoon. In its shallowest part this ditch attains a maximum depth of about 12ft., and it was at the bottom the log was found across the drain. The wood is almost black, like Irish "bog oak," resembling ebony in texture. When cutting the sawdust was very fine. From its appearance the wood is probably one of the eucalyptus; if so it throws an interesting light on the antiquity of this genus, as it must have been buried many thousands of years. Where the log was met with, the first 3ft. or 4ft. consisted of chocolate soil, merging into a yellowish clay loam, deepening again about 10ft. into peaty substance. Further up the dyke a thick bed of shingle, intermingled with stones of rounded form about as large as a mouse's head, took the place of clay. This was probably the bed, while the bottom, where the log was found, was no doubt muddy. Towards the lagoon the material excavated is dark peaty soil, continued to the edge of the necross. From the whole appearance of the surrounding land the alluvial deposit is one of great age, rendering the discovery of great interest, not only on account of its antiquity, but in connection with the capability of the particular species of tree to withstand decay throughout such a lengthened period.

Mr. R. M. JOHNSTON said he had examined the wood superficially; he would not, however, be prepared to say what it was unless by a microscopic examination. It was a highly lignified specimen, and he had met with similar woods on the West Coast. Woods of this kind commonly occur in drifts in other parts of the colony.

THE FAN-TAILED CUCKOO IN TASMANIA.

The **Secretary** read the following paper, also by Colonel Legge, on finding of a fan-tailed cuckoo in Tasmania, in which it was stated that the writer observed a beautiful adult example of *Cuculus flabelliformis* (fantailed cuckoo) near Apsley, East Coast, the country passed through being gum, she-oak, and Oyster Bay pine bush; the cuckoo lodged on a branch by the road side, affording a good view of its plumage. Such a late occurrence of this migrant was worthy of record; it was improbable that it would winter here; for several summer visitants have been observed in this sheltered region late into the winter, and this cuckoo probably made a prolonged sojourn through the mild climate. *Cuculus flabelliformis* inhabits most parts of the continent, from Cape York to Victoria, and westward to West Australia, and far inland beyond the Murray. It arrived here about the end of September or beginning of July, and left at the end of March and throughout April. Mr. O. Adams saw one at Piper River on July 24, 1887.

SOUTHERN STONE PLOVER.

The **Secretary** read some notes upon the discovery of the Southern stone plover (*Ædicnemus grallarius*) in Tasmania, in which he showed that the bird had a very wide distribution over the Australian Continent. The body is nearly the size of that of a hen pheasant, and the flesh of excellent eating. The habits of the bird resemble those found in Ceylon. It inhabits sandy plains, crowns and sides of grassy hills and flats, between the mountain ridges particularly. Occasionally it is met with in pairs, and sometimes in small flocks. It is shy, and runs with great rapidity, but when not inclined to fly it squats down on its legs by the side of a stone or log, and remains so close to it that it may be almost trod upon before rising. One of the birds was sent by Mr. McCluskey, Spring Bay, and the other by Mr. F. Morris, Swansea. The bird was excellent for the table, and he trusted it would increase and multiply. The plumage of the specimens submitted would seem to indicate that they were in too good a condition to have been blown over.

Mr. B. **Shaw**, who had shot over every inch of the country where the birds were taken, said he did not remember having ever heard of or seen the plover under discussion.

PROOFS OF GLACIATION AT LOW LEVELS.

The **Secretary**, for Mr. T. B. Moore, F.R.G.S., read a paper on this subject, based on observations made by him on the King River, between Pine Cove and Strahan, where he found large ice-worn boulders striated and grooved in the deep gorge of the river near the upper landing. The boulders were composed principally of silurian sandstone; the planed surfaces, grooves, and striæ were fairly distinct, proving beyond doubt that the transportation of the boulders by ice was of very recent date.

Mr. R. M. **Johnston** said on a future occasion he would take an opportunity to give his reasons for not accepting the conclusions arrived at by Mr. Moore. He read a few notes which he himself had made on discoveries of evidences of glaciation in Tasmania by geologists over 20 years ago.

NEW GUINEA STONE ADZES.

The **Secretary** submitted six stone adzes, which, he said, were the finest specimens he had ever seen. They were of a kind of greenstone, the heaviest being 10¾in. in length and 10½in. in girth. The adzes were from the Fly River, New Guinea, and were presented to the Museum by the Rev. James Chalmers with other valuable and interesting ethnological specimens.

COMPLIMENTARY.

The CHAIRMAN, in moving the customary votes of thanks to the writers of the papers submitted, took the opportunity of commenting upon some of them. Regarding the specimen of wood submitted by Colonel Legge, he said he would not be at all surprised to find that it was some resinous sort of pine and not a eucalypti. The ornithological papers by Colonel Legge and Mr. Morton were most interesting to lovers of natural history. Mr. Moore also deserved the thanks of the Society for his paper, which was valuable, considered as the result of careful observations.

The meeting then concluded.

SEPTEMBER.

The monthly evening meeting of the members of the Royal Society of Tasmania was last held on Monday, September 7th, in the Art Gallery of the Museum. A lecture on "The Primary Law of Value or Price," by Mr. R. M. Johnston, F.L.S., Government Statistician, was given.

Mr. Bernard Shaw presided, and among those present were :—The Treasurer (Hon. P. O. Fysh), Messrs. F. W. Piesse, M.L.C., N. E. Lewis, M.H.A., Henry Dobson, M.H.A., Rev. J. B. W. Woollnough, M.H.A., etc.

The SECRETARY (Mr. Alex. Morton) read a letter from His Excellency's private secretary, intimating that owing to domestic bereavement Lord Gormanston was unable to attend. Letters of apology were also read from Sir James Agnew, the Premier (Sir Edward Braddon), the Minister of Lands (Hon. A. T. Pillinger), Hon. T. Reibey, M.H.A., and Mr. Mackenzie, M.H.A.

The CHAIRMAN having formally introduced the lecturer,

Mr. JOHNSTON first spoke of the proper use of economic, terms. Under the generic term "wealth" there was exchange wealth, social wealth, national wealth, cosmopolitan wealth, capital wealth and consumable wealth. Many used the term "wealth" in a loose way. In the same way there was individual capital, consumption capital, fixed capital, auxiliary capital, potential capital, circulating capital, and personal capital. Then there was utility—total utility and marginal and final utility. Under "value" there were such expressions as price or exchange value, money value, unit of value or ratio of exchange, economic price, present value, deferred value, capital value, and annual value. Under "rent" there was ground and building rent, producer's rent, ability rent, wage-earner's rent, economic rent, and quasi-rent. "Under price"—economic price, equilibrium price, monopoly price, loan price, fancy price, famine price, robbery and violence price. Then under "wages" were nominal or money wages, and a more important thing—rent wages, or purchasing power. He expounded the proper applications of these terms. There was the primary law of value or price, and that was the subject of his discourse. He argued that economic cost of production (and not the illusive and indefinite something called the ratio of demand and supply), was the primary law which regulated and determined the respective ratios and prices at which the precious metals and all other commodities and services exchanged with each other. The "scarcity of gold" theory of the decline of prices could not be reconciled with plain facts, for the decline of 58 per cent. in cotton cloth was conjoined with an increase of 112 per cent. in the wages of the operatives since 1847. The fall of 58 per cent. in prices was likewise irreconcilable with the ratio of demand and supply theory. Cheapened cost of production, the true primary law of economic price, was the only theory which harmonised with all the facts. Theories as to the scarcity of gold or the appreciation of gold and ratio of demand and supply, which could only at best be reconciled with a very small part of the facts, must be abandoned as unsatisfactory and altogether misleading. Supply was subordinate, and depended upon demand, whilst the cost of producing the supply was the primary law which determined its economic price. Then if it be true that cost of production was the true primary law of economic value or price, it might be confidently asserted that any attempts made by Governments to fix arbitrary laws for determining the relative exchange values of any commodities (such as gold and silver in the scheme of bimetallism) would be as futile as to pass arbitrary laws for determining the absolute specific gravities. The true cause of decline in prices was due to the increasing improvements in steam, chemistry, and labour-saving machinery. He concluded by quoting the author of "Recent Economic Changes" (Mr. David A. Wells) in saying that "to suppose now that a change in the relative value of the two precious metals (gold and silver), a change which has not in any degree restricted their natural supply or diminished their monetary or industrial use, has exercised a concurrent, superior, and predominatory influence in respect to the prices of all other commodities or services, would seem to be almost incompatible with the clear exercise of one's reasoning faculties."

The address was illustrated by a number of cleverly-prepared diagrams.

Mr. FYSH characterised the paper as a most able and elaborate dissertation, and one which would be classified and appreciated among scientific papers of the kind throughout the world. If, however, they found that the primary law of value or price was the economic cost of production, many of them would have to turn themselves inside out in regard to their settled theories.

Mr. WOOLLNOUGH felt doubtful as to the results Mr. Johnston had arrived at, whilst still having great confidence in his talent in such matters.

Dr. BENJAFIELD wanted to know whether to-day it was taking double as much labour to produce a ton of gold that it did 20 years ago?

Mr. JOHNSTON: No; it's just stationary. It's the cost of producing silver that has reduced.

Dr. BENJAFIELD insisted that gold was produced to-day cheaper than ever, and in larger quantities.

Mr. JOHNSTON: The quantity does not settle its cost.

Mr. FYSH thought that there Mr. Johnston's difficulty came in.

Dr. BENJAFIELD remarked that the purchasing power of gold was higher to-day than it had been known to be for many years.

Mr. JOHNSTON dissented.

Further discussion on the paper was adjourned.

It was desired by several that the paper should be printed, and Mr. MORTON appealed to the Treasurer to have it printed in the Government Printing Office.

A vote of thanks to Mr. Johnston was then passed, and the CHAIRMAN, in moving it, expressed regret on behalf of the Society for the cause which had led to the absence of the Governor. He also referred to the recent visit of Mr. Wragge, and the marvellously accurate forecasts of the weather which that gentleman had recently given.

OCTOBER.

At a meeting of the Royal Society of Tasmania on Monday, October 21, discussion was resumed upon Mr. R. M. Johnston's paper on "The primary law of value or price," which was read at the previous meeting of the Society. The Hon. Sir James Wilson Agnew presided, and there was a good attendance of ladies and gentlemen, among whom were the Hon. P. O. Fysh, Mr. Justice Dodds, Hon. Adye Douglas, M.L.C.; Bishop Montgomery, and Hon. C. H. Grant, M.L.C.

MRS. MEREDITH'S WATERCOLOURS.

The **President**, in opening the meeting, mentioned that an effort was being made to secure Mrs. Meredith's watercolour drawings of Tasmanian fish, flowers, shells, etc., and to present them to the Society. Considerable amount of success had already attended the effort, but more money was still needed for the purpose, and if any public-spirited individual could afford to help, the members of the Society would be very grateful. The paintings were on view downstairs, and he advised those present to inspect them before they left the building.

APOLOGIES.

The **Secretary** (Mr. A. Morton) read letters of apology from His Excellency the Governor, Hon. J. Henry, Messrs. E. Hawson (secretary of the Chamber of Commerce), T. E. Hewitt, James Whyte, and James Barnard, senior vice-president.

MR. JOHNSTON'S PAPER.

The **Chairman** said he had repeatedly read Mr. Johnston's pamphlet, and thought he had clearly proved his case—that the cost of production regulated the price.

Mr. A. J. **Ogilvy** said he thought the thanks of the whole community were due to Mr. Johnston for having so ably brought the subject forward. He (the speaker) was not going into any particular application of the principle—bimetallism or anything else—for it was no good to go into the application until it was settled whether the principle was the true one. Mr. Johnston's opening statement when condensed was that the cost of production, not demand and supply, primarily determined prices. Later he qualified that by excluding things the cost of which was determined by scarcity alone, confining it to things which could be increased indefinitely, and where competition operated without restraint. That price would always represent cost of production measured in labour if there were no natural scarcity or artifical interference Mr. Johnston had proved conclusively, but the case thus qualified seemed so plain from the mere statement of it that one was surprised to hear that it required proof. The ratio between demand and supply as such was the sole governing power of the movement of prices, notwithstanding that behind demand and supply was cost of production. The doctrine of demand and supply was that the value of everything was determined by its scarcity, as compared with the demand for it. If there was no demand for it it would have no value, no matter how scarce it might be. However, let them keep to the main point, which was that looking at the matter broadly and taking price as a whole as it actually was with all its disturbing influences, not as it might be without them, it was demand and supply as such that determined it, cost of production acting only by affecting supply and so disturbing the ratio, besides being only one factor out of many, though no doubt the chief one, in affecting supply.

Mr. FYSH said he had read Mr. Johnston's paper twice. When he first read the pamphlet he was disposed to dissent, but when he had read it again and had studied it more fully he asked—"Who questions it?" For so clear was it to him that the primary law of value or price was the economic cost of production that it seemed outside of argument. All they had to do was to follow the phraseology of the writer —"the primary law of value or price." There was "value" and "price," and value and price with the writer were the same thing. Therefore the primary law of value (leaving out price) must be the economic cost of its production. And the more they thought it out the more surely they arrived at that conclusion, and yet not break down the experience as to the law of supply and demand. As to gold, he was not so able to follow Mr. Johnston's argument. They could not make an artificial price of it.

Mr. JOHNSTON: Gold is measured by itself.

Mr. FYSH: Measured by an arbitrary standard of value. And if the output was so reduced that it could not be overtaken, we would be obliged to fall back on some other mineral, such as bismuth, and which is more scarce than gold at present. Gold was, after all, only a matter of exchange—a convenience for exchange and measure. The more he read the more he was convinced that Mr. Johnston was right with respect to the law of value and price. Take wheat and meat for instance. That he demonstrated by facts. The thing was to limit themselves to his terms, and then they had only to ask themselves—"Who is going to question it?" The law of supply and demand was quite separate from the law of economic cost of production.

Hon. ADYE DOUGLAS said he had come to learn, not to instruct, not having had time to dip into the subject. With regard to the economical production theory put forward they must all agree to that. So far as he had been able to read the pamphlet, he quite agreed with Mr. Johnston.

Hon. C. H. GRANT said he had only cursorily read the pamphlet, but was inclined to agree with Mr. Johnston's demonstration that the primary law of value and price was the economic cost of production. As to wheat, notwithstanding the increased demand and supply, the cost had been enormously reduced, and that was accounted for by the increased facilities of transit—steam and the triple expansion engine.

Mr. JOHNSTON: That has largely accounted for it—also the reaper and binder.

Mr. GRANT: Thus value and price are determined by economic cost of production. The same principle applies to the reduced cost of meat.

Dr. BENJAFIELD, in a lengthy address, said there was no question that in the early state of society the cost of production was the value, but we live in different times now, and all that had changed. Ricardo, Adam Smith, and others were superseded by the opinions of up-to-date men. Mr. Johnston had told them that "gold was our established foot-rule for measuring value, and the standard of itself could not show any variation"; again, that the falling of prices could not be due to the appreciation of gold. All that seemed to him (Dr. Benjafield) to be fallacious. Professor Nicholson, of Edinburgh, one of the leading authorities in Britian—[Mr. JOHNSTON: "He is not the best"]—said it was impossible to take labour as a unit of value. Wells, whom Mr. Johnston had quoted with a flourish of trumpets, as a modern authority, said prices were controlled by supply and demand; that when production was checked prices advanced. [Mr. JOHNSTON: I agree with that.] Mr. Johnston had told them that the quantity of gold did not regulate prices; that the scarcity of gold had nothing to do with prices. Mill said that if the whole money in circulation was doubled prices would be doubled. Giffen, a greater authority than Ricardo—[Mr. JOHNSTON: He was not a political economist]—showed that the alterations in value and prices were due to the scarcity of gold; that the gradual adjustment of prices must be subject to the gradually smaller supply of gold; that a fall in prices implied a contraction in money, but Mr. Johnston laid it down emphatically that it was not so. [Mr. JOHNSTON: Certainly.] Professor Foxwell, of Cambridge, said: "There can be no question that where the value of money has risen the price of commodities has fallen." Giffen said that banking facilities did not meet the difficulty, and did not compensate for a scarcity of gold. Saurbeck said that a great increase of production and an insufficient supply of gold were the causes of lower prices.

Mr. Justice DODDS rose to a point of order. He thought gold should not be considered as gold, for the purposes of the discussion, for gold had a fixed standard that was simply used as a medium of exchange. Mr. Johnston's paper dealt with the primary cost of the production of commodities, and that had not a fixed standard.

The CHAIRMAN: That is the point.

Mr. JOHNSTON: Hear, hear. This is bordering upon the question of bimetallism.

Dr. BENJAFIELD (proceeding) said that Professor Nicholson ridiculed the idea of gold being a foot-rule, as the value of a sovereign was changing frequently. Mr. Johnston had said that the fall of silver was due to cheapened production. Giffen said that its purchasing power was greater than ever, and had not really fallen at all. They should speak of silver as appreciating a little and gold a very great deal. They would find that what had occurred to silver had occurred to gold. The cheaper means of abstraction of gold had also been very great. Last year's output was the largest, yet its purchasing power had doubled within 20 years,

Mr. FYSH: Why do you argue it is scarce? Is it scarce?

Dr. BENJAFIELD said it was scarce in the banks.

Mr. FYSH referred to the millions lying idle in the banks.

Dr. BENJAFIELD said that gold appreciation had occurred through legislative interference, and silver had failed to equally appreciate through the same cause.

After Mr. WOOLLNOUGH, M.H.A., had offered some observations, the discussion was adjourned for a week.

At an adjourned meeting of the Royal Society of Tasmania on Monday, October 28th, Sir James Wilson Agnew, K.C.M.G., M.D., M.E.C. (Vice-President) occupied the chair, and there was a good attendance of both ladies and gentlemen. The meeting had been adjourned until this evening to further discuss Mr. R. M. Johnston's paper on "The Primary Law of Value or Price."

DEATH OF MRS. MEREDITH.

The CHAIRMAN, upon taking the chair, said:—Ladies and gentlemen,—Before we proceed to business I have to say how sorry I have been to hear this afternoon—and I am sure you are very sorry too—of the death of Mrs. Charles Meredith. Mrs. Meredith has been a distinguished resident of Tasmania and a hon. member of this

Society for many years. She died to-day in Melbourne. You will recollect that the last time we met I brought under your notice some of her works which it is very desirable should be secured for the Society. They consist of books and pictures of shells, animals, and flowers. They have been on view downstairs, and several people have been to see them. Now they are up in this room (the Art Gallery), and perhaps after this meeting is over some who are present would like to inspect them. The works are bound in the best style, as all her works are, and now by the intelligence of her death a melancholy interest is attached to them.

NEW MEMBERS.

The Hon. Thos. Reibey, M.H.A., and Mr. J. G. Mitchell, of Jericho, were balloted for, and unanimously elected members of the Society.

LETTER FROM MR. WRAGGE.

Mr. Clement L. Wragge wrote from the Chief Weather Bureau, Brisbane, as follows :—

My Dear Morton,—This letter is an official one to you as secretary to the Royal Society, and I will beg you to read it before the Fellows. I must confess that I am much disappointed that the Government of Tasmania have not voted the funds necessary to continue the maintenance of the new meteorological service of Tasmania; but I learn at the same time, with sincere gratification, that it is proposed to hand over the local direction of the Tasmanian weather service to your Society. I am sure that the interests of this service will be jealously and safely guarded by your august body, and that your Society will do its utmost to take such steps as may be necessary to maintain, not only the observatories at Hobart and on Mount Wellington, but also the out-stations in different parts of the island. Of course, it was on the distinct understanding that these stations are maintained, or to put it in other words, that data are forthcoming from these stations, that I undertook to cable daily to Tasmania, without any expense whatever, the forecasts issued here for your island. It will at once be evident that if the Tasmanian stations cannot be kept going, the forecasts cannot possibly be up to the present standard of accuracy. I have reason to believe that they have already been found of considerable practical utility, and it will be most deplorable in public interests if the present efficient service cannot be kept afloat. I would therefore earnestly commend the Meteorological Department of Tasmania to the special care of your Society, and feel sure that you will recognise in Mr. Kingsmill, as Government Meteorologist for Tasmania, one who has thoroughly the interests of his department at heart, and do what you can to assist him in these important duties. I am pleased to hear that the country has, at last, determined to recompense him for the outlay he so generously expended in order to establish the coast stations and the observatory on Mount Wellington. I am leaving next week for Cape York Peninsula, and for a long and extended tour of inspection in Central and Northern Queensland generally. If you have anything important to communicate, please write or wire to me at the Post and Telegraph Office, Cooktown, N.Q., until further notice ; but should you have communications that can be dealt with during my absence, please address my first assistant, Mr. Archibald W. Anderson, Chief Weather Bureau, Brisbane. Mr. Anderson will issue the forecasts during the time I shall be away from here. He has been specially trained by me, and I have every possible confidence in his work. Please convey my respectful regards to Sir James Agnew, your vice-president, the members of your Council, and the Fellows of your Society.

The letter was received.

THE PRIMARY LAW OF VALUE OR PRICE.

Mr. W. Knight, M.A., barrister-at-law, resumed this discussion upon Mr. Johnston's paper by reading a paper in which he criticised Mr. Johnston's views very strongly. Mr. Johnston, he contended, took an extreme view of the principles of the value and the use of gold. The demand for gold was never kept pace with. It had a monopoly value, and therefore Mr. Johnston had not sufficiently taken into account the value of capital.

Mr. J. W. ISRAEL read a paper showing that he was in agreement with what Mr. Johnston had advanced. He read a paper on the subject eight years ago and then came to similar conclusions. He then went into economic principles to show the evidence of the same.

Mr. THOS. TAYLOR urged there was another law besides the cost of production which regulated prices. From the fifties to 1870 prices went up, notwithstanding the cheapening of the cost of production.

Mr. A. J. TAYLOR thought speakers had not paid sufficient attention to Mr. Johnston's paper and diagrams. Dr. Benjafield and others had spoken of conditions of things which Mr. Johnston excluded. He thought Mr. Johnston had successfully set out to prove that the law of value or price regulated and determined the ratios and values of precious metals, and all other commodities, and was to be found in the economic cost of production. He thought Mr. Johnston had established that the primary law of value had to do with the cost of production.

Hon. NICHOLAS J. BROWN, M.E C., said: Taking a broad view of the subject, all over the world it seemed to him inevitable that the average prices realised for commodities must bear a distinct relation to the cost of production, and he could not understand why such elaborate calculations and diagrams were so necessary to prove it. He was, however, unable to see what practical value these assertions of Mr. Johnston were. He supposed the object was to prove that those who agitated for bimetallism were entirely in error. On that question he was not prepared to definitely commit himself; but he thought, from that point of view, Mr. Johnston seemed to have the right end of the stick, for he could not understand how giving a fictitious value to silver could have any effect whatever, unless there was an agreement to use it as such on the part of the whole of the nations of the world.

Mr. RULE did not think Mr. Johnston had demonstrated his thesis. No one would dispute that cost of production was an important factor; but on the question of supply and demand a lot was left unproved.

Mr. JOHNSTON, in reply, complained that his paper had been largely misunderstood by some of the speakers. His paper went to show that the economic cost of production, not supply and demand, was the initial element in the control of prices. He had confined himself to economic cost. He showed how the intellect of men and capitalists had lessened labour. He did not ignore capital as having helped. The dominant law was the cost of production. There must be a pivot for supply and demand to work upon—the equilibrium price; economic cost of production was the major law in controlling price. Gold could never measure itself. He denied that he had shown that cost of production meant a general decline of prices. When they took lengthened periods in their investigations they saw how the influence of supply and demand fell short. Cost of production included carriage and distribution. As to bimetallism, there was no local market for gold or silver. The world was the market. If the quantity of money determined the matter, prices of commodities should have risen, because gold had become more plentiful, and not have fallen.

A hearty vote of thanks to Mr. Johnston was passed on the motion of the Hon. P. O. Fysh.

NOVEMBER.

The monthly meeting of the Royal Society of Tasmania was held in the large room of the Art Gallery on Monday, November 25th, Sir James Agnew presiding. There was a large attendance.

Mr. L. RODWAY read a paper "On some New Botanical Specimens."

A paper from Mr. WEYMOUTH on some New Mosses.

Mr. J. B. WALKER read a paper on "Abel Jansen Tasman: His Life and Times." He said that for long Tasman was neglected by his own countrymen, but at this late date a good deal of close attention was being given to the existing records of his work. About the time of Tasman the Dutch had become the carriers of the European peoples. Powerless before their enemies on land, the Dutch took to the sea. They cut off the wealth brought by Spain from the New World, and by that means found the wherewithal to carry on the conflict. The Hollanders swept the seas, and harried the Spaniards at their pleasure. Philip forbade Dutch ships to trade with any port of Spain. But the blow fell upon himself and crippled the trade of Spain. Various attempts were made to find a shorter route to India. Baffled in their search in the North, the Dutch turned their attention to the old route by the Cape of Good Hope, and along that line acquired the practical monopoly of the great trade of the East Indies, particularly of the Spice Islands. The Dutch also took possession of Japan and Ceylon. Sir Walter Raleigh gave some most interesting figures as to the extent of Dutch trade, and the effects of Dutch maritime enterprise. Such was the position of the Dutch nation at the time of Tasman. Amsterdam was the centre of the world's trade, and the richest city in Europe. In 1603 Tasman was born, in a small inland village in a remote province of Holland. The locality was inhabited by representatives of the fine Frisian race, who differed much from the typical Dutch. Tasman was probably a Frieslander. No information concerning Tasman's family was obtainable, and nothing was known of his youth. But after an apprenticeship in the fisheries of the North Sea it was natural that he should get to Amsterdam. The first authentic information concerning him showed him living as a widower with one young daughter in one of the poorest streets of Amsterdam. Tasman married again, and made his first voyage to the East at the age of 28. His promotion was rapid; from the rank of a simple sailor to that of a master, he rose in two years. On the acquisition of the monoply of the valuable spice trade the Dutch concentrated all their energies. They succeeded—at the cost of much bloodshed and long-continued embitterment. Tasman's singular capacity soon made itself obvious to the colonial authorities, for he shortly had command of a small fleet in East Indian waters. Desiring thereafter to visit the old land, he accepted a subordinate position as mate of the ship Banda. On arrival he remained at Amsterdam for some months, when he returned to the Indies, taking his wife with him. In 1639, a year after his return to Batavia, Tasman was selected to assist in the work of discovery. Anthony Van Diemen was at that time Governor. Tasman was on service which took him to the coasts of China and Japan. Here reports again came of a golden island to the eastward. Tasman commanded one of the ships fitted out for the quest, being second in command. After long searching over a wide area the venture was abandoned, after the loss of 50 of the 90 men who made up the number of the expedition. The Dutch were very anxious at that time to discover the great south land, of which there had long been rumours. Already, before the expedition after the golden island, a Dutch ship found itself, by an error of longitude, off the coast of Western Australia. In a few years that coast was well known to Dutch mariners. Anthony Van Diemen at length fitted out an expedition of two ships to discover the Great South Land, with Tasman in command, and Fischer, a famous pilot, second. The ships touched first at Mauritius, remaining there to refit and provision a month. They sailed, and got down to lat. 49deg. They fell off to lat. 42deg., and then struck the coast of Tasmania, somewhere near the entrance to Macquarie Harbour. Getting round to Bruny they tried to make Adventure Bay, but were driven out. Thereupon they named Frederick Henry Bay, now known as Blackman's Bay. Sailing from the coast they made New Zealand near Cook's Strait, and had an encounter with the natives. New Zealand Tasman held to be the veritable Great South Land. The Tonga Islands were next reached, and from there a homeward course was shaped past New Guinea. With the result of the expedition Van Diemen was not satisfied, but two years afterwards he again sent Tasman and Fischer out. Of that second voyage in 1644 no journal was kept. Tasman's services were recognised somewhat grudgingly by a small increase of salary. Of the rest of his life very meagre information was extant. There were no more great expeditions of discovery. Later, Tasman was suspended from his office as a punishment for executing a seaman without trial. Being reinstated after two years, he shortly afterwards left the service of the company. Of his last days little was known. He died in 1659.

Very admirable lantern illustrations were supplied by Mr. J. W. Beattie, and exhibited by Mr. N. Oldham.

A hearty vote of thanks was accorded to the lecturer.

The Hon. ADYE DOUGLAS said the very admirable lecture they had just listened to was the last of the session. Their thanks were due to the vice-president, Sir James Agnew, and in moving that a vote of thanks be accorded him he would add the name of Mr. Barnard. Sir James Agnew and Mr. Barnard had belonged to the society for 54 years.

The vote of thanks was carried by acclamation, and the recipients briefly responded.

CLOSE OF THE SESSION.

The CHAIRMAN announced that the evening's meeting closed the session for 1895. He was sure all would agree that many valuable papers had been read and much exceedingly useful information had been gathered and ventilated during the session of 1895.

The meeting then terminated.

FUR SEALING IN BASS STRAITS.

On Wednesday, September 12, 1894, a deputation, consisting of Sir James Wilson Agnew, K.C.M.G., M.D., M.E.C., Bishop Montgomery; Messrs. Curzon Allport and Alex. Morton from the Royal Society, and Mr. H. W. Knight, representing the Fisheries Board, waited upon the Premier (Sir Edward Braddon) and the Chief Secretary (Hon. W. Moore) relative to the granting of a close season for the fur seals in the islands of Bass' Straits.

Sir **James Wilson Agnew**, K.C.M.G., M.D., M.E.C., in introducing the deputation, said their object was to ask that something should be done for the preservation of the fur seals in Bass Straits. If sealing were allowed to be prosecuted unchecked for two or three years it was certain that the seals would be exterminated. Therefore, on the score of humanity alone, it was desirable that something should be done to preserve these interesting and valuable animals.

Bishop **Montgomery** said he had discussed the question in Bass Straits with the actual sealers, and in no single instance did he find anybody who wished the sealing to be thrown open altogether. Although they did not want the sealing to be entirely closed, as it had been of late, they were unanimous that some restriction should be made so as to prevent the extermination of the animal. He pointed out that every factor which had led to the closing of the seal-fishery three years ago existed now, and that it was absolutely necessary that something should be done for their protection. He did not know the exact value of the seal in the market, but he knew that the half-castes, in whom he took a great interest, were anxious to make money from sealing, and if the industry were thrown open all the year round the traders would come in and sweep the rocks without any reserve, with the result that the industry would be completely destroyed. The sealers themselves had told him that it was perfectly heart-rending to hear the young seals crying for their mothers which had been killed, and the end of these young creatures was that they died of starvation. Therefore on the ground of humanity, and also on the ground of conserving an industry to benefit the half-castes, who were the only remnants of our aboriginal population, he impressed on the Government the necessity for proclaiming a close season for the seals.

Mr. **Curzon Allport** regretted the enforced absence of Mr. Seal, the chairman of the Fisheries Board, who had the entire matter at his finger ends. The Fisheries Board had no personal interest in the sealing; it was comprised of a body of men who knew perhaps more than others about the subject, and they considered that if a close season were abolished, they might say good-bye to the seals in every portion of Tasmania. It was during the period that the young seal was with its mother that protection was necessary, because at that time the mother would not leave its young, and the consequence was that both mother and progeny were at the mercy of the merciless traders. Ten weeks had been suggested as the duration of the close season, but he thought it would be rather more than that. Tasmania should take to herself the credit and kudos of protecting such an important industry as the sealing. The Fisheries Board had given the matter their very fullest consideration, and he thought, with all due deference, that their opinions should receive a little more consideration at the hands of the Government, especially as the opinions and suggestions were for the welfare of the colony. He did not think there would be any difficulty in arranging with other Governments for the protection of these animals, for they would be only too ready to meet any reasonable recommendations with a view to such protection. The natives themselves were desirous of a close season being instituted, which was a strong point for the granting of the request. He believed that the existing police power in the islands would be quite enough to see that the law was carried out.

Mr. A. MORTON, to show how important the industry had been in the past, and might be made again in the future, said that a few years back as many as 36,000 seals were taken from Bass Straits in one season. But they were then killed indiscriminately, male and female and young, so that afterwards the animals became so scarce that the natives could not make a living at the industry. The Fisheries Board had recommended that the sealing should be closed for a period, and now fortunately the seals were again more numerous, but unless protection were still afforded they would soon be killed off again. New South Wales, Victoria, and New Zealand recognised the importance of a close season, and why Tasmania could not recognise the same he, as a member of the Fisheries Board, could not comprehend. The Board were not asking the Government to close the industry altogether for another three years, but simply for a short period each year that the females and young might be protected. In justice to the other colonies, Tasmania should institute a close season, for otherwise it led to a good deal of illegal sealing in other colonies. This had been particularly the case when New Zealand instituted a close time in Campbell Island, and Tasmania left Macquarie Island open. The present deputation, however, had no reference to Macquarie Island, but they did hope that the Government would allow to become law the resolution which had been unanimously passed by the Fisheries Board, and supported by the Royal Society, asking that a close time should be afforded seals.

Sir JAMES AGNEW pointed out that the protection asked for would entail scarcely any pecuniary expenditure whatever on the part of the Government.

Mr. H. W. KNIGHT said the reason of the deputation waiting upon the Government was in consequence of the notification by the Fisheries Board to the Royal Society that the proposed regulations formed by the Fisheries Board had been declined by the Government. The Royal Society and the Fisheries Board were both deeply interested in the matter, and the regulations had been prepared after very mature consideration and minute inquiries from those people who were engaged in the sealing, and whose interests would thereby be protected.

Sir EDWARD BRADDON, in reply, said he, of course, had to speak with some hesitancy on the matter, inasmuch as it was one upon which he would have to consult with his colleagues. But as far as his judgment guided him he agreed with the deputation, that in the interests of humanity, and in the interests of the industry, which was a more or less important one, it was desirable that there should be a close season when the young seals were about. So much he might say, and, fortunately, his hon. colleague, the Chief Secretary, agreed with him. That expression of opinion would, he hoped, to some extent satisfy them, and he could only say that the matter would be immediately taken into consideration with a view to seeing what could be done to meet the request.

The deputation then withdrew.

DEPUTATIONS TO MINISTERS.

MOUNT WELLINGTON AS A METEOROLOGICAL AND ASTRONOMICAL STATION.

Sir JAMES AGNEW introduced several members of the Royal Society to the Chief Secretary (Hon. W. Moore) on Friday afternoon, April 19, 1895, and said it gave him pleasure to do so because he thought the object was a good one, being for the purpose of putting the colony's meteorological observations on a more useful, sound, and scientific basis. The deputation called to ask the Government to request permission from the Queensland Government for Mr. Wragge, a celebrated meteorological observer, to pay a visit to this colony. It was sought to establish a meteorological station on Mount Wellington, and Mr. Wragge was so well known in the other colonies that it was believed he could enlist their support in the matter. It was well known that these meteorological observations were useful to this and all other colonies. If South Australia, Victoria, Queensland, and New South Wales were to join in the movement the expense to each would be comparatively small. But all the Government was asked for now was to get permission for Mr. Wragge to come here, and frank him to come and go. There would be no other expense, because Mr. Kingsmill had asked Mr. Wragge to be his guest. If an observatory were established here under Mr. Wragge's directions they knew it would be well done, and in the right direction, probably eventually leading to an astronomical observatory being attached. It was known that Mr. Russell, of the Sydney Observatory, was anxious to get an observatory on Mount Wellington, where the atmospheric conditions were peculiarly favourable. It was the most southern point in Australasia, and was in many ways especially adapted for an observatory. This would be a great attraction to Hobart, and any little expense incurred would be more than recouped by the establishment of a meteorological and astronomical observatory up there.

The METEOROLOGICAL OBSERVER (Mr. Kingsmill) read extracts from a letter from Mr. Wragge showing that a meteorological station on Mount Wellington would be of great service. Mr. Wragge established a station on Ben Nevis, in Scotland, and another at Fort William, at the foot of Ben Nevis, where simultaneous readings were taken more than once a day, and these supplied important data. Naval officers stated that they had every confidence in Mr. Wragge's skill and forecasts. It was possible that something might be got from him in the way of making of some arrangements for sending his forecasts here by telegraph.

The GOVERNMENT STATISTICIAN (Mr. R. M. Johnston) said that the captain of H.M.S. Penguin had spoken strongly of the advantage it would be to have the proposed station on Mount Wellington. It would greatly aid the preparation of forecasts, and ensure their greater certainty. Captain Balfour assured him that in his own experience more than 70 per cent. of Mr. Wragge's forecasts were verified, and that with them he could go to sea with the greatest confidence. Anything that would improve such data and enable greater provision to be made for the safety of ships at sea was of national importance.

Mr. MORTON (secretary of the Royal Society) and Colonel LEGGE supported the request.

The CHIEF SECRETARY said it was a pleasure to say that the Government would extend every sympathy to such an object as the Royal Society were desirous of carrying out. There would be no difficulty in the way of asking Mr. Wragge to come to Tasmania, nor in extending to him a free railway pass, but the Government was in no position to contribute to his expenses. A report from Mr. Wragge as to the establishment of a meteorological and astronomical observatory would be of great value to the Government and the Royal Society. When the scheme was fully complete, however, it would be quite soon enough to submit it to the Government.

THE DESTRUCTION OF BLACK SWANS.

The deputation, on leaving the Chief Secretary's office, went down to interview the Attorney-General (Hon. A. I. Clark) in reference to the wholesale destruction of black swans, and Sir **James Agnew**, in introducing them, said that their object was one which should have the sympathy of every member of the community. They wanted to protect from destruction one of the most interesting birds in Tasmania. The destruction of black swan was admittedly carried on in a barbarous manner about Swansea. At one time these birds existed in the colony in great numbers, but of late years their destruction had been carried on in a barbarous manner, for not only were they shot down in great numbers, but they were allowed to lie and rot, and their nests were robbed of the eggs. This was very destructive, because nothing was calculated to drive away birds from their haunts so much as robbing their nests, as no doubt the Attorney-General knew perfectly well. Perhaps the shooting of the birds was not so bad as robbing their nests. The only way to accomplish the object in view was to stop the destruction of the birds for one or two years at the outside. By that time the birds would be back again to their haunts, and people would be shown the evil of their ways, and a better state of public feeling would prevail.

Colonel **Legge**, as the Tasmanian member of the Australasian Committee for the Preservation of Native Fauna, said that since coming to Hobart he had taken the opportunity of writing to the Royal Society laying before the Council the information he had lately received at Swansea, and he could fully bear out everything said by Sir James Agnew. One of the greatest resorts of the black swan in Australasia was the Moulting Lagoon. At the beginning of the season people went there from 50 miles round to shoot, and there was great slaughter. Not half the birds shot could be taken away. The birds were driven some distance and then shot, being left to rot. It was stated that swans were not decreasing in the bay, but he found that they were becoming more scarce year by year in the outlying waters. If the birds were protected for two years, it would enable them to come back again. It was not only shooting the swans in such a wholesale manner, but there was the mischief of taking the eggs. The people who committed these depredations suffered a loss, because the swan was a really valuable article of food.

The **Attorney-General**: The birds come under the present Game Act, don't they?

Colonel **Legge**: Oh, yes; and it is penal, as you know, to take the egg of a game bird.

The **Attorney-General**: I suppose if the Game Act was stringently enforced it would be sufficient protection?

Colonel LEGGE: As regards the eggs; but we want the birds protected.

The COMMISSIONER OF POLICE (Mr. Shaw) protested against the use of the word barbarous in reference to anything done by Swansea people. He was assured by a resident that the swans were not shot and allowed to rot on the shore and in the water, but were all carried away, with, possibly, the exception of a tough old customer that even the Attorney-General might find hard to tackle. On the first day of the season as many as 400 swans were shot.

The ATTORNEY-GENERAL: How long does a swan keep after it is shot?

Colonel LEGGE: It all depends upon the weather.

Mr. SHAW: The birds were very numerous, and more flew away than were shot. At the same time he cordially agreed that protection for a couple of years would have a good effect. He heard that the eggs were taken, but it was a difficult thing to prevent, the eggs being, as a matter of course, deposited in out-of-the-way places. He had seen the remains of swans on the shore at Macquarie Harbour, and had shot them on the North-East Coast. Swans, he believed, were more numerous throughout the colony this year than formerly.

Colonel LEGGE repeated that numbers were shot and not taken away.

The ATTORNEY-GENERAL said that he would be very glad to introduce a short amendment to the Game Act this session in the direction indicated. It appeared to him that stealing the eggs was the greatest evil Mr. Shaw might instruct the police to be more vigilant than they had been.

Mr. SHAW said that people went on expeditions with boats to take the eggs.

The ATTORNEY-GENERAL thought that in such cases they might be caught.

Colonel LEGGE: People who buy and eat the eggs are as responsible as those who take and sell them.

Mr. CLARK: We should have to make it penal to have egg shells about the place. The only thing seemed to be to protect the birds for a year or two.

THE DEPORTATION OF THE NORFOLK ISLANDERS TO THE DERWENT IN 1808.

By James Backhouse Walker.

I.—The Settlement of Norfolk Island.

The laborious and valuable researches made in the English State Record Office by the veteran historian, Mr. James Bonwick, have a great interest for Australians, and mark a new departure for the historian of the Australian Colonies.

The Government of New South Wales has shown its sense of the value of the documents which Mr. Bonwick has discovered by printing them *in extenso.*[*] Our own Government, equally mindful of the importance of these records for the elucidation of our early history, has with a wise forethought availed itself of Mr. Bonwick's special knowledge to secure copies of the papers relating to the settlement and earliest history of Tasmania. Of this period no contemporary records have been preserved in our local archives; our knowledge of those early times has hitherto been derived merely from vague and inaccurate tradition. The material supplied by Mr. Bonwick, and placed at my disposal by the courtesy of the Government, has enabled me to lay before the Royal Society the first authentic story of the planting of Tasmania and of the motives which led to it.

In former papers which I have had the honour of reading before the Society we have seen how the occupation of our island came about. It was merely one episode of the long life-and-death struggle which England waged with France under the first Napoleon. It was due to the dread of possible injury to England from the sudden intrusion of a hostile French settlement in such close proximity to the young English colony at Port Jackson. The first puny occupation by Bowen at Risdon in September, 1803; the expedition of Collins to Port Phillip and its transfer to Hobart in February, 1804; the occupation of the Tamar by Paterson in August of the same year, and the consequent settlement of northern Tasmania, were all parts of the far-seeing and persistent policy by which the great English statesmen of that day did much to ensure the fall of Napoleon's power, and to give to England her world-wide dominion.

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[*] Up to this date (1895) five volumes have appeared, viz., Historical Records of New South Wales, 1762-1795 (3 vols.); History of New South Wales from the Records, 1783-1789 (2 vols.)

The next chapter in our colonial history to which I ask your attention, demands for our comprehension of its significance that we should leave these high questions of statesmanship, and turn our view for a time to a small and solitary island, separated from us by more than a thousand miles of ocean, the fortunes of which have, nevertheless, been strangely interwoven with those of our own colony.

Situated in seas where perpetual summer reigns, endowed with great natural beauty, rich in the fruits of the tropics, few spots in our modern world have had a history so strange, so various, so horrible, and yet so romantic, as that of Norfolk Island. At the present time it is the secure retreat of an easy and indolent race, who are yet the descendants of the actors in one of the most noted and picturesque piratical deeds recorded in English annals. It is, moreover, the peaceful headquarters of a Christian mission to the savage islands where the saintly Patteson laid down his life. It is most familiar to us as a synonym for cruelty and crime, a reminiscence of the days when the distant island formed a dependency and a part of the then penal settlement of Van Diemen's Land. To the majority this, which is within the memory of many still living amongst us, is the only known link between our colony and it—perhaps the only known fact respecting its earlier history. Comparatively few are aware that—with the single exception of Sydney—Norfolk Island is the oldest English colony in the South Seas. Perhaps still fewer know that to that same far-off island, so familiar to us in later days under another aspect, Tasmania was indebted for a large proportion of her earliest colonists. To this historical fact the familiar names of New Norfolk in the south, and Norfolk Plains in the north of this colony remain a perpetual but unappreciated memorial.

The history of Norfolk Island and its early colonists thus becomes an essential part of the history of Tasmania. The history of its colonisation and settlement can be gathered from scattered references in the works of Collins and other contemporary writers, but Mr. Bonwick's researches in the Record Office enable me to lay before the Royal Society the first authentic story of the evacuation of the island and the transference of all its free settlers to the Derwent in 1808.

And first as to its discovery. The first voyage of Captain Cook, lasting from 1768 to 1771, was that in which he did his most memorable work. The immediate object of the expedition was the observation of the Transit of Venus at Tahiti in the South Seas. But the voyage had more important results than astronomical observations, valuable as these were to science. In his little north-country collier of 370 tons, the *Endeavour*, Cook rediscovered and examined the islands of New Zealand, and then steering for the as yet unknown coast of New Holland, anchored in Botany Bay (28th April, 1770), and examined the whole eastern coast, to which he gave the name of New South Wales. In two short years of this memorable voyage our great navigator had practically added the possessions of Australia and New Zealand to the English Crown, a work possibly only second in its importance in the world's history to the discovery of America.

Though Cook's first voyage was beyond question the most fruitful in results, yet the more leisurely explorations of his second voyage in the *Resolution* and the *Adventure*, extending from 1772 to 1775, are fuller of interest to the reader. Cook himself states the object of this second expedition to have been "to complete the discovery of the southern hemisphere." His first voyage had proved that if, as the geographers believed, any great southern continent did exist, it must lie far to the south of the latitude of New Holland. In three successive years during this second voyage Cook sailed to the far south, making three unsuccessful attempts to penetrate the frozen sea, and finally demonstrating that the dream of centuries had no foundation, and that there was no *Terra Australis Incognita* outside the limits of the circumpolar ice. In the intervals between his attempts on the Antarctic Ocean, Cook employed the winter months in making further explorations in the Pacific, and his journals contain most fascinating descriptions of this first view of the islands of the south and of their inhabitants in their original wild condition. In 1774 he employed his time in cruising among the Pacific Islands, beginning at Easter Island, with its gigantic stone figures, mysterious relics of a forgotten civilisation. Thence, after a stay at his beloved Tahiti, he worked westward among the islands to New Caledonia on his way to make his third and final attempt on the Antarctic Circle.

On the 10th October, 1774, as the *Resolution* was slowly ploughing her way from New Caledonia towards New Zealand, land was discovered bearing S.W. It was found to be an island of good height, five leagues in circumference. The island was bounded by rocky cliffs on nearly every side, with 18 to 20 fathoms water close to the shore. Cook says, "I named it Norfolk Isle, in honour of the noble family of Howard."

The boats were launched, and the weather being exceptionally favourable, the captain landed without difficulty behind some large rocks on the north-east side, near what was afterwards known as the Cascades. Along the shore was a belt of thick scrub, and beyond this a dense forest of a sort of spruce pine, the trees as thick as two men could fathom, and exceedingly straight and tall. The soil was rich and deep, and the Captain found many trees and plants common to New Zealand, particularly the flax-plant, growing near the sea most luxuriantly, and much finer than he had seen it in New Zealand. The woods abounded with pigeons, parrots, parrakeets, hawks, and many New Zealand birds. The island was uninhabited. The party from the *Resolution* may have been the first human beings to tread its tangled forests, though it is possible that at isolated periods previously Maori canoes had been driven by heavy south-east storms from the coast of New Zealand, and that shipwrecked Maoris had maintained an existence on the island for years; for in the early days of the settlement two canoes were found on the beaches, and it is said stone adzes resembling those in use in New Zealand were turned up when the land was being broken up for cultivation. Cook gave but a few hours to the examination of the island, and on the following day sailed away for New Zealand. On the publication of his book, his description, brief as it was, of the capabilities of Norfolk Island, of its rich soil, its dense pine forests, and profuse growth of New Zealand flax, attracted attention to it as a desirable possession. Consequently, when the Government in the year 1787 resolved on establishing a penal settlement at Botany Bay, it was determined to occupy this promising island as a dependency of the principal colony. In the Royal instructions to Governor Phillip the following passage occurs:—"Norfolk Island . . . . being represented as a spot which may hereafter become useful, you are, as soon as circumstances admit of it, to send a small establishment thither to secure the same to us, and prevent it being occupied by the subjects of any other European power." The instructions also contain directions to the Governor as to the cultivation of the flax-plant, and its use in manufacturing clothing for the convicts and also for maritime purposes.

Little more than a week after Governor Phillip had landed on the site of Sydney (6th February, 1788), Philip Gidley King, then a young lieutenant on board H.M.S. *Sirius*, received his commission as Superintendent and Commandant of the settlement of Norfolk Island, with orders to take a small party of people and some live stock to this distant isle, which was intended to serve as a place of seclusion for troublesome characters, and as a possible succour for the main settlement in case of famine. The party placed under King's charge was very similar to that which 15 years later he himself despatched under Lieut. Bowen to occupy Risdon on the Derwent. It consisted of an officer and surgeon from H.M.S. *Sirius*, four seamen and two marines from the same vessel, with nine male and six female convicts. They sailed from Port Jackson in the armed tender *Supply*, and were 14 days before, on 29th February, they came in sight of their destination. For days they cruised round the island searching in vain for a harbour or even a landing-place, sometimes in the ship, sometimes exploring the shores in a boat, but everywhere baffled by the inaccessible cliffs or the thundering surf of the ocean swell on the rocky beaches. At last, after five days' search, and when they had almost despaired of success, they found a beach in a bay on the south side of the island, protected by a long reef extending parallel with the shore and about 150 yards distant from it. At the end of the reef was an opening, little more than sufficient to allow two boats to pass each other, which gave access to the smooth water inside. Here King got his little party landed with their stores, and soon had a small patch of ground cleared and tents pitched. Having settled his colony, King now proceeded to explore his new domain. He describes the island as six miles long and four broad, and estimated it to contain about 11,000 acres. The ground was everywhere covered with an almost impervious forest, through which he forced his way with great difficulty. The principal tree was the pine, which grew everywhere. These great trees were often 140 to 200 feet high, 30 feet round at the base, and 80 feet to the first branch. The roots sometimes ran two feet above the ground twisted in all directions. In this forest grew a sort of supplejack as thick as a man's leg, hanging in festoons from tree to tree, and forming a network which was well nigh impenetrable. From the highest point of the island, 1200 feet above the sea-level, which he named Mount Pitt, he had a view of a continuous forest without a break, for in its natural state there was not a yard square of clear ground on the whole island. The soil was deep and rich, but not a blade of grass grew anywhere. Pigeons and parrots were in great numbers; the pigeons so tame that they could be knocked over with a stick. These explorations were made with great difficulty, and the explorers often returned with their clothes torn to shreds. To conquer the virgin forest King had only 12 men, and one of these was an old man of 72, another a boy of 15. Small as the company was it was a difficult one to manage. Before a month passed the boy, having been caught stealing rum, was punished with 100 lashes, which King in his diary remarks he hoped would have a good effect; and later on we hear of a woman being punished in a similar way. To add to the Commandant's troubles all his people were ill with scurvy from their salt diet, and his first attention was given to obtaining fresh provisions. At first they got turtle, but these were soon scared away. The fish supply was precarious, as fishing was only possible in calm weather. Their chief resource was the pigeons, and the birds which abounded on Mount Pitt gave them many a good meal. A few banana trees were found growing not far from the settlement, but for vegetables they were chiefly dependent on nikau-palm, the crown of which furnished a good vegetable not unlike a cabbage.

Under these circumstances the progress of the settlement was very slow, but gradually, as the little colony was reinforced by fresh drafts from Sydney, ground was cleared and brought under cultivation, huts and store-houses were erected, and a weatherboard cottage, 24 feet by 12 feet, was built for a Government house. In January, 1790, two years after his first landing, there were on the island 79 male and 33 female convicts and 32 free settlers; in all 144 souls. King's administration of Norfolk Island lasted (with one interval) from February, 1788, to September, 1796, a period of eight and a half years. He has left a diary of those days extending over many quarto pages of print. It is dreary reading, being a chronicle of petty crimes and rough punishments, of crops destroyed by blight or grub, of disorders, conspiracies, and mutinies among the prisoners, of discontent among the settlers whether free or emancipated. King ruled this turbulent community like a sailor, with a mixture of rough severity and good-natured lenity, dealing out barbaric punishment to offenders, and eqally barbaric indulgences as a reward for improved behaviour.

The early attempts at agriculture were not very successful. When his first little patch of wheat came up the south-west wind blighted it and turned it black ; the next crop (and many a one after that) was nipped oft by a small black caterpillar which came in thousands; others were destroyed by a great worm ; much was eaten by parrakeets; and even when the wheat was harvested it was attacked by the weevil and rendered useless. The rats—the only animals on the island—ate his Indian corn, in spite of traps and pounded glass mixed with oatmeal which slew them in hundreds. The most successful crops were potatoes and vegetables. Nor was he more successful with his live stock than with his agriculture. There being no grass on the island the stock had to be fed on herbs and plants. The sheep succumbed and died, partly from starvation, partly from scab. The pigs suffered greatly from poisonous herbs, and he had great difficulty in feeding them until he found that a tall palm or fern, growing 80 feet high, had a soft core tasting like a bad turnip, on which the hogs throve splendidly.

In spite of all these misfortunes, however, and in spite of the calamity of a hurricane of wind and rain from the south-east which laid waste and nearly destroyed the camp and the plantations, the little settlement struggled ahead.

In January, 1790, the Commandant records with pride that he had 30 acres of land in cultivation and his free settlers 18 acres. He had in store 300 bushels of wheat and 140 bushels of Indian corn.

While King was thus rejoicing in the progress of his little colony, he little thought of the troubles which were impending, and which were destined to make the year 1790 a sad and memorable year for the Norfolk Islanders.

To understand the position of affairs we must turn for a moment to the principal settlement at Port Jackson. The two years' supply of provisions which the First Fleet had brought out was now nearly exhausted, and every one at Port Jackson was in daily and anxious expectation of the arrival of ships from England with a fresh supply. In February only four months' provisions, calculated at half allowance, remained in store. It was impossible to say when relief might arrive, and the prospect of starvation began to stare them in the face.

In this emergency Governor Phillip resolved to divide the settlement, and send a large body of convicts and soldiers to Norfolk Island. The Commandant had constantly written in such high terms of the rich soil of the island that it seemed a garden of fertility in comparison with New South Wales, and the Governor thought it would easily support a larger population, and thus relieve the distress of those left in the principal colony. Accordingly, Captain Hunter was ordered to prepare H.M.S. *Sirius* for sea, and embark 186 convicts and a company of marines, while the armed tender *Supply* was to accompany her with 20 convicts and another company of marines. This would make an almost equal division of the people between the island and the main settlement at Port Jackson. Major Ross, the Lieut.-Governor, was to be placed in command of the dependency in place of Lieut. King, who had obtained leave to visit England. A proper proportion of the remaining provisions and stores were put on board, and the ships sailed for Norfolk Island on the 6th March, 1790. A week's sail brought them to the island, and not being able to land in Sydney Bay on account of the surf, they ran round to Cascade Bay on the north side, and in two days contrived to land the people, 270 in all. Before they could land the stores a storm came on and the ships were driven out of sight of land. It was four days before the *Sirius* could make the island again. The *Supply* was already in Sydney Bay, and the signal was flying that the landing was safe. Captain Hunter therefore stood in, loaded the boats with provisions and sent them in to the landing-place within the reef. Meanwhile, as the *Sirius* was settling fast to leeward, Hunter made sail to get her out of the bay, but could not weather the rocks off Point Ross on the western side. The ship twice missed stays and then slowly drifted stern first towards the reef opposite the settlement, and struck. The masts were instantly cut away so that she might lift on to the reef, as she was in danger of going to pieces from the force of the seas that struck her. This was 11 A.M. All the provisions that could be reached were immediately got on deck and secured. This accomplished, a line was floated over the reef with an empty cask, and a hawser hauled on shore and made fast to a tree. At 5 o'clock the surgeon's mate was hauled ashore through the surf on a traveller fastened to the hawser, and by dark Captain Hunter and most of the seamen were landed, having been dragged through a heavy surf, many being much bruised. The captain was so exhausted that he was nearly drowned. The rest of the crew got ashore next day.

The situation of the settlement was extremely critical. There were now on the island 506 souls on half allowance of provisions, which would last a very short time unless the stores could be saved from the *Sirius*. Lieut.-Governor Ross therefore assembled the officers, and it was resolved that, as under the ordinary law there was no power to punish serious offences on the spot, it was absolutely necessary for the general safety to establish martial law. Further, that all provisions, public and private, should be thrown into a common stock in the storehouse, and put under the charge of three persons, viz., Captain Hunter, a person appointed by the Governor, and a third person to be named by the convicts. On the fifth day after the wreck, and before any of the provisions had been saved from the *Sirius*, the *Supply* sailed for Sydney, with Lieut. King and part of the crew of the *Sirius*, to carry the disastrous news to Port Jackson, where it created fresh consternation and deepened the prevailing gloom; the more so from the impossibility of sending relief to the unfortunate Norfolk Islanders.

Fortunately, after the *Supply* left they were able to get out of the wreck a large part of the provisions, though much was lost or spoiled. For some weeks Lieut.-Governor Ross, Captain Hunter, and the people shut up in the lonely isle entertained a glimmering hope that they might see the *Supply* return with the comfortable news of arrivals from England. Long and anxiously they scanned the sea, and when hope failed and they had come to the reluctant conclusion that Governor Phillip could not relieve them, but had been obliged to send Lieut. Ball on more pressing service, their situation began to wear a very alarming aspect.

The weekly allowance of food was now still further reduced, and Captain Hunter records in his journal his apprehension that before long many of the convicts, who often ate at one meal the whole week's allowance, would be dead from starvation, or executed for depredations. This gloomy anticipation would doubtless have been realised but for an unexpected resource which was discovered.

In the month of April the people who were searching the island for food found that Mount Pitt was crowded with birds. These sea-birds were away all day in search of food, but as soon as dark came on they hovered in vast flocks over the breeding-ground, which was hollowed by innumerable burrows. The seamen, marines, and convicts went out to Mount Pitt every evening, arriving soon after dark. They lighted small fires to attract the birds, which alighted faster than the people could knock them down. After killing 2000 to 3000 birds every night there was no sensible diminution in their numbers at the end of May. The people called the bird "Pittites;" Phillip in his voyage gives it the name of the Norfolk Island Petrel. It is known to us in Tasmania as the Mutton Bird.

Captain Hunter in his journal calls it the *Bird of Providence.* Such it undoubtedly was to the Norfolk Islanders, who, but for its timely and wholly unexpected arrival, must have perished in numbers from starvation. It is true that the sea abounded in fish, and the neighbouring islets (Phillip Island and Nepean Island) swarmed with countless multitudes of sea fowl, but they were unattainable. For a month together the surf ran so high that not more than once or twice during that time was it possible to launch a boat, and even then the fishing was often unsuccessful, while the islands that the sea-birds frequented were usually inaccessible on account of the tremendous surf.

Towards the end of July the birds on Mount Pitt began to get scarce. As only 10 or 12 days' salt provisions at short allowance were now left, the Lieut.-Governor reduced the ration to three lbs. flour or maize meal and one pint of rice per week. The people were so reduced by want of food that hardly any work could be done, and it was with great difficulty that the little crops could be got in.

On the 4th August, while in this deplorable state, with famine staring them in the face, one of the sailors came running into the settlement, crying out—"A ship! a ship!" Men, women, and children rushed out to welcome her, and Captain Hunter and many of the people hurried across to the north of the island to communicate with her; but when they arrived in sight of her, in spite of their signals, she stood off before the wind and sailed away. Hunter, in his journal published some years later, speaks of their bitter disappointment and indignation at the want of humanity in the captain who, although he might have nothing for them, might at least have informed them of the near approach of relief.

From the appearance of the ship the people were convinced that relief was not far distant, and three days later two ships hove in sight. They proved to be the *Justinian* and *Surprise,* from Port Jackson, with provisions and 200 convicts. The mystery of the non-arrival of supplies from England was now cleared up. The *Guardian,* Captain Riou, had sailed from Plymouth for Sydney with provisions in August, 1789, but she had been wrecked at the Cape, and it was not until the arrival at Port Jackson of the Second Fleet in June, 1790, that the people felt the danger of starvation to be past.

.The relief at last sent to the islanders had with unacccountable want of consideration been delayed two months after the arrival of the fleet, and it arrived only just in time. The mutton birds had deserted the island, the fish also had failed them entirely, and a delay of another six weeks would have meant death by starvation for the greater part of the inhabitants.

Captain Hunter did not get away from the island, which was associated with so much suffering and anxiety to him, until February, 1791. He considered its capabilities much overrated, for—while he admits the richness of the soil—the crops were liable to destruction by blight, grub, caterpillar, and other plagues. The timber of which so much had been expected was very inferior. Instead of being able to support 2000 people as Governor Phillip expected, he thought 500 too many, and these should be such as had forfeited all hope of seeing their native country again, and would know that their existence depended on their industry. He recommended the Government to remove the establishment to Port Dalrymple, as its only use could be to supply South Sea whalers with fresh meat and vegetables; though he admitted that as a place for incorrigible criminals the colony had this advantage—that escape was impossible. Of the island he says, "It is a dreadful place, almost inaccessible with any wind."

Notwithstanding the unfavourable opinion of Captain Hunter and others, Governor Phillip continued to send fresh batches of convicts and small settlers, and when Lieut.-Governor Ross gave up the command to King, on the return of the latter from England in September, 1791, the population had increased to over 800 souls.

King had now the rank of Lieut.-Governor of Norfolk Island. He had founded the colony, and took the most sanguine view of its capabilities, and of the practicability of making it prosperous and self-supporting. Besides getting a large area of land under cultivation by the labour of the prisoners, he encouraged these whose time had expired to take up small allotments for growing vegetables and grain. A number of soldiers and sailors were also induced by the offer of grants of land up to 60 acres to become agricultural settlers.

The greatest obstacle to the progress of the settlement lay in the character of the people. King says of the prisoners that while some were well behaved the bulk of them were miserable wretches. Collins, in his account of New South Wales, gives a deplorable picture of the disorder and crime which were rampant at Port Jackson, and as the selection for Norfolk Island consisted of the worst and the doubly-convicted, the condition of affairs in the island was not likely to be better than in Sydney. The settlers were mostly soldiers and sailors and others who had little or no knowledge of agriculture, and were full of grievances and complaints. Still the colony increased in population and production. At the end of 1793 there were 1008 souls on the island. The settlers had become a considerable body, and they had command of a plentiful supply of labour in the expiree prisoners who had hired themselves out to farm-work. The Government took into store all grain grown by the settlers at a fixed price per bushel. This so stimulated production that in the year ending May, 1794, there were grown 34,000 bushels of maize and wheat. The settlers were all prosperous, and the Lieut.-Governor was able to offer to send, if required, 20,000 bushels to Sydney for commissariat use. The supply was now so large that the Governor was obliged to refuse to purchase grain which he could make no use of, and the settlers found themselves without a market. Many gave up their farms; many left the island; others turned their attention to raising hogs, which had multiplied exceedingly. In 1795 King could offer the Sydney commissariat 40 tons of cured pork which had been salted on the island.

It will be remembered that the New Zealand flax plant was most plentiful at Norfolk Island. Lieut.-Governor King was very anxious to develop the manufacture of the fibre into cordage and canvas. Many attempts were made but with small success, as no proper method of dressing the fibre could be discovered. King's method of grappling with this difficulty is sufficiently characteristic of the times. He offered to Captain Bunker, of the whaler *William and Ann*, £100 to kidnap two natives of New Zealand and bring them to Norfolk Island as instructors in the art of flax-dressing. Captain Bunker did not succeed in earning the money. King seems to have made his views known to the Admiralty, for when the *Dædalus* storeship was employed to carry provisions to the Sandwich Islands for Vancouver's discovery ships, Lieut. Hanson who commanded her was directed to touch at New Zealand on his way back to Sydney and try to supply King's wants. The *Dædalus* accordingly touched at New Zealand, about Doubtless Bay, and Lieut. Hanson having enticed on board his ship two Maoris, named Tuki and Uru, at once made sail and carried them away to Governor King. The Maoris, who had been frantic with grief when they found themselves entrapped, were very sullen on their arrival at Norfolk Island, and absolutely refused any information respecting the flax. King says: "The apprehension of being obliged to work at it was afterwards found to have been a principal reason for their not complying so readily as was expected. By kind treatment, however, and indulgence in their own inclinations, they soon began to be more sociable. They were then given to understand the situation and short distance of New Zealand from Norfolk Island, and were assured that as soon as they had taught our women to work the flax they should be sent home again. On this promise they readily consented to give all the information they possessed, and which turned out to be very little. This operation was found to be among them the peculiar province of the women; and as Uru was a warrior and Tuki a priest, they gave the Governor to understand that the dressing of flax never made any part of their studies." Whatever may be thought of the means King employed to obtain the services of Uru and Tuki, it must be acknowledged that he fulfilled his promises to them very handsomely. He decided to accompany them to New Zealand, and embarked with them and a guard of soldiers on board the *Britannia* to take them back to their homes. This was safely accomplished, and the Governor and his Maori friends parted with great expressions of mutual regard.

The instruction given by Tuki and Uru, meagre as it was, was sufficient to enable a few hands with very primitive appliances to manufacture 30 yards of coarse canvas in a week, and the Lieut.-Governor stuck pluckily to his manufactory, maintaining to the last that it was a valuable industry, and could easily give employment to 500 hands.

On the 25th October, 1796, Lieut.-Governor King gave up the government, which he had held, with a short interval, for nearly nine years, and proceeded by the *Britannia* to England. Shortly afterwards he received the appointment of Governor of New South Wales, in which capacity, in 1803, he despatched Lieutenant Bowen to establish the first settlement in Tasmania.

On leaving Norfolk Island he wrote an account of the condition of the settlement, which is printed in Collins' "New South Wales"; the population was 887, and of these only 198 were convicts. He says that 1528 acres had been cleared. Besides huts and cottages a Government-house, storehouses, and military barracks had been built. A water-mill had been erected at the Cascades, and this and two windmills ground the corn which each man had formerly to grind for himself. There were two schools on the island.

Of the fertility of the land he spoke highly; the principal products were maize, wheat, potatoes, and vegetables. The yield of wheat averaged 18 bushels per acre. Maize gave two crops a year, averaging 45 bushels per acre, and often reaching as much as 70 to 80 bushels. He calculated that if the whole of the arable land was put under cultivation it would produce 225,000 bushels of grain, or even 450,000 if fully cultivated. There was little live stock, a few cattle and sheep, a number of goats, and fully 5000 swine. The swine might be a great source of revenue; up to that time 500,000 lbs. of pork had been used or exported.

With King's departure the settlement began to retrograde; but the story of its gradual decline and the final deportation of its settlers to Tasmania must be left to be dealt with in a future paper.

II.—THE DEPORTATION TO THE DERWENT.

In the last paper which I read before the Society I sketched the strange story of the first planting of a European colony in an island of the South Sea,—the settlement of Norfolk Island by Lieut. King in the year 1788, and its fortunes during a period of eight years. I now propose to trace the history of its failure and abandonment, and the transfer of its settlers to our own island.

From his first landing in February, 1788, Lieut. King had formed the most sanguine expectations of the future. He was charmed with the beauty of the island. With such a genial climate and such a fertile soil it should grow into one of the most flourishing and valuable of colonies. From this view he never wavered. To secure this result he struggled bravely and pertinaciously to overcome the difficulties of nature and the perversity of man. Nature met him on the threshold with a well nigh inaccessible coast and a dense and tangled forest, and fought him with hurricanes and blighting winds, with drought and caterpillars, which marred his labour. But to rule and organise the unpromising human material with which he had to work, and to turn it to account in the face of laziness and disaffection, was a more trying task than to conquer nature. Still, during those eight or nine years he had fought his way through difficulty and not a few disasters to the attainment of a very fair success. When in September, 1796, he resigned his government, he left with the feeling that the settlement to which he had given some of the best years of his life had overcome its first difficulties, and was firmly established with a bright outlook for the future. The little island had a population of nearly 900 people, who dotted its surface with clearings and cottages. More than a third of its area (5247 acres) was occupied, and 1528 acres cleared and cultivated. The production of grain and pork not only sufficed for the wants of the inhabitants, but left a large surplus for exportation to New South Wales. And yet the resources of the island were, in his view, only beginning to be developed. Instead of a population of 1000, he considered it could easily support more than twice that number, and could more than quadruple its products. By ordinary methods it would be easy to produce a quarter of a million of bushels of grain; careful husbandry might even double that quantity. In King's opinion it might become a paradise for small landholders, who would be enriched by the labour of those convicts whom it was desirable to isolate from the main settlement. The settlers would consist of soldiers, sailors, and the better class of expiree prisoners, while forced labour would clear and cultivate their lands and build their houses. New South Wales would benefit by the removal of the worst and the most turbulent, and these would be easily controlled in an isolated dependency by a small military force, and under strict discipline would be transformed into a means of wealth to the community instead of being a menace to its order. The mistake of the New South Wales settlement had been that it had been formed exclusively of convicts, but in Norfolk Island the true solution of the transportation question would be found. It would be a community of free settlers, to which the convicts would supply labour. It would be not only a self-supporting but a profitable penal colony.

When Captain King left Norfolk Island for England in the *Britannia* in 1796, he handed over the command to the principal military officer, Captain Townson, of the New South Wales Corps. Now that the island produced grain and meat enough to feed its inhabitants, its most pressing want was a vessel expressly appropriated to its service, and always ready for communication with Sydney. Vessels were so few at Port Jackson that none could be spared for the exclusive use of Norfolk Island. Captain Townson therefore determined to try what the island could do for itself. The indigenous pine provided timber in plenty, but appliances were few, and the want of a harbour presented almost insuperable obstacles to ship-building. However, after some months' labour, there stood upon the beach before the settlement a little craft of 25 tons, built of Norfolk Island pine, completely rigged and equipped for sea. An ingenious man on the island made a quadrant with which to navigate her. She was launched from the shore, and had to go on her voyage to Sydney without any further preparation. Probably she was strained in launching, for she proved to be very leaky. With the aid of two pumps, however, the little crew managed to keep the water under, and she safely reached Port Jackson (15 June, 1798) with the Commandant's despatches to Governor Hunter. This vessel, the first and the only one built at Norfolk Island, was named the *Norfolk*, and though little more than a decked longboat, she was destined to do good service and attain a certain celebrity. Captain Townson and the Norfolk Islanders were not allowed to benefit by the vessel which they had built with so much difficulty. When she reached Port Jackson Flinders and Bass were burning with anxiety to solve once for all the vexed problem of Bass Strait and the insularity of Van Diemen's Land. They persuaded Governor Hunter to fit up the *Norfolk* for a voyage of discovery, and four months after her arrival at Sydney she sailed with those two adventurous explorers, passed through Bass Strait, and accomplished the first circumnavigation of Van Diemen's Land.

In April, 1800, Captain King returned to New South Wales from England, but he did not go back to his old government at Norfolk Island. He had brought with him His Majesty's Commission as Lieutenant-Governor of New South Wales, and when Governor Hunter left Sydney for England in September, 1800, King succeeded him in the government of the principal Colony.

Before Governor Hunter's departure, and in accordance with orders from Home, Major Joseph Foveaux, of the New South Wales Corps, was appointed Commandant of Norfolk Island, and assumed the Government in July, 1800. Matters were in a bad way in the island. With the withdrawal of King's zeal and energy improvement had ceased. The population had increased somewhat, but in all other respects the settlement was steadily going back. Governor Hunter, who touched at the island on his way to England in H.M.S. *Buffalo* (October, 1800) to land some mutinous Irish prisoners, gave a deplorable account of its condition. Its appearance was most unpromising. All the buildings were in a state of rapid decay, and but few signs of industry were visible. The people were idle and refractory, the crops were mostly a failure. All they could supply to the *Buffalo* was a few hogs and some vegetables.

The sanguine hopes of King were doomed to disappointment. The island had been at first occupied chiefly with a view to developing the manufacture of New Zealand flax. This had proved a complete failure. Much had been expected from the pine forests ; but the timber was found to be unfit for ship-building and too brittle for spars, even if it had been possible for ships to lie there and take it in. The soil was fertile, it is true, but from the uncertainty of the climate and the many plagues—drought, blight, and caterpillars—the crops oftener than not yielded but a poor return. The project of settling pensioners and expirees had proved abortive. The soldiers and sailors were mostly too ignorant of farming to succeed, and the inveterate idleness of the bulk of the settlers of another class had been a still more insuperable obstacle to their prosperity. Moreover, they were discontented and disaffected, and laid the blame of all their misfortunes upon the Government.

Governor Hunter was not alone in his opinion. Collins, who had ample opportunities of forming a correct judgment, speaks in his work on New South Wales of Norfolk Island as the place for transporting offenders who had been again convicted in New South Wales, and that this was more dreaded than the first transportation. He thought that for this purpose it might be continued as an alternative for the gallows, but as a settlement the expense was quite disproportionate to any advantage to be derived from it. From the reports of Flinders and Bass on the climate, soil, and harbours of Van Diemen's Land, he thought that territory would be found much more profitable than this parched and inaccessible island.

Such was the condition of affairs when Major Foveaux took over the command in July, 1800. Foveaux was not the man to cope with the situation, or to infuse a spirit of order into a disorganised society. As if with the intention of making his task more difficult Governor King added a new trouble by banishing to the island a number of the most turbulent of the Irishmen who had been exiled to New South Wales for their participation in the rising of 1798: they had given much trouble at Port Jackson through their mutinous conduct, and it was thought that by banishing the most turbulent to the distant settlement they could be kept under better restraint. But in Norfolk Island society was even more anarchical than in the principal colony, and there was abundant opportunity for plotting. In December, 1800, a conspiracy was discovered among the Irish, the object being to overpower the officers, seize the island, and escape. As the Irish numbered only 36 men, while there was a force of 100 soldiers and 26 constables, the plot could scarcely have been called formidable. But, if Foveaux was unable to preserve order, he could at least take summary and barbarous vengeance. He received full information of the plot on a Saturday evening. On the Sunday morning the people went to church as usual. When service was over all the Irish were ironed and put into gaol. At two o'clock the Commandant had a gallows erected, and two of the ringleaders, John Whollahan and Peter M'Lean, were brought out and forthwith hanged without trial or examination.

In the memoirs of the so-called General Holt we have some graphic sketches of the state of Norfolk Island under Major Foveaux's government in 1804. Joseph Holt was a prominent leader of the United Irishmen during the rising of 1798, and was transported—or to speak more correctly, exiled—to New South Wales as a political prisoner. As a State prisoner Holt was allowed full liberty in the Colony, and being a man of ability and energy attained a fairly comfortable position. At the time of the Castle Hill rising in 1804, however, he came under suspicion, more on account of his antecedents as a rebel leader than from any actual proof of his complicity in the plot. Governor King, however, made up his mind that Holt was a dangerous character, and banished him to Norfolk

Island. There is no doubt that Holt's picture is strongly coloured by his prejudices, and must be taken with large allowances, but the account he gives of the arbitrary cruelty which reigned under Foveaux is too surely corroborated from other sources to be very far from the truth. As a political exile Holt was legally a free man in New South Wales, though subject to certain restrictions. He had not been convicted of any crime when exiled to Norfolk Island, yet immediately on arrival he was clapped into gaol, and by Foveaux's orders was illegally put into the working gang as a convict. At first he refused to work, but, mindful of the absolute power of the Commandant, who was sole judge and jury, he finally submitted. For some three or four months he was kept in the gang, in which the men were subjected to most brutal treatment from the overseers. At length, under the combined effect of severe labour and exposure and insufficient rations Holt broke down, and in consequence of strong representations from Surgeon D'Arcy Wentworth to Foveaux of the illegality of this treatment, he was exempted from further labour and given his liberty. He remained on the island for 15 months longer, until Major Foveaux was succeeded in the command by Captain Piper. Holt describes Norfolk Island in these terms: "The dwelling of devils in human shape, the refuse of Botany Bay, the doubly damned."

In spite of Governor King's partiality for the settlement he had founded, it was becoming evident to the Home Authorities that Norfolk Island was never likely to become a successful Colony, and that it would always continue to be an expensive burden on the Government. Dr. Lang, in his "History of New South Wales," roundly charges King with having, from some interested motive, done his best to discredit the settlement at the Colonial Office. In the absence of any direct proof, and from the general tenor of King's conduct with regard to the changes in the establishment, this charge seems to be wholly without foundation. It is much more probable that the views of such men as Hunter and Collins, with the unsatisfactory reports of the condition of the settlement, and its great expense, prompted the Home Government to decide to reduce the establishment, if not to abandon the island altogether.

At the same time, Governor King's urgent representations of the danger which was impending over the new Colonies from the designs of the French had roused the English Government to take active measures to forestall them. In December, 1802, the Cabinet had decided to form a settlement at Port Phillip, and in the following April Colonel Collins' expedition had been despatched for that purpose.

Still the Government was uneasy; and in June, 1803, Lord Hobart wrote to Governor King that the position of Port

Dalrymple in Bass Strait rendered it particularly necessary, from a political point of view, that an establishment should be placed there, and directed him for that purpose to remove from Norfolk Island a portion of the settlers and the convicts, and send them to Port Dalrymple under the command of Lieut.-Col. Paterson, at the same time recalling Major Foveaux to Sydney. Lord Hobart's despatch did not arrive at Port Jackson until May, 1804, nearly 12 months after it was written. Collins having in the meantime abandoned Port Phillip for the Derwent, the importance of occupying a station in Bass Straits became more urgent, and King at once applied himself to carry out his instructions respecting the settlement of Port Dalrymple, which was eventually accomplished by Paterson settling at George Town in November, 1804.

King did not show the same alacrity in complying with the instructions respecting Norfolk Island. There is little doubt that they were distasteful to him. He contented himself with writing to Foveaux (23 June, 1804) that the establishment was to be reduced, and that towards the end of the year he would send a vessel or vessels to remove any settlers who were inclined to go to the new colony at Port Dalrymple. At the same time he said that he did not wish to force removal on any settlers who were valuable and industrious, and who might be ruined by having to give up their land after the expenditure of so much labour and the endurance of so much hardship. Nor, on the other hand, did he want the useless and idle, who might be only too willing to move. Still, out of the 33 larger landholders there might be some who would be willing to go, and they should be encouraged by the offer of liberal terms. They and their stock would be removed at the public expense, and what was necessarily left behind would be taken by the Government at a valuation. On surrendering their grants they were to have four acres for every acre cultivated at Norfolk Island, and two acres for every acre of waste land. They were to have rations for twelve months for themselves and their households, and be allowed the labour of two convicts for the same period. Of the 180 little occupiers there might be a few who were worthy of encouragement and removal.

On receipt of the Governor's instructions Foveaux assembled the settlers (19th July, 1804), and laid the proposal before them. It was well received, and some 40 at once gave in their names as ready to try their fortunes in Van Diemen's Land. These 40 were free settlers, most of them being men who had been either in the army or the navy. A considerable proportion held grants of from 30 to 120 acres each. A few had flocks of sheep; one, George Guest, as many as 600. Amongst those who were strongly recommended by Foveaux as the most industrious and fittest for selection we find the names of

Daniel Stanfield, Abraham Hand, John and Joseph Beresford, George Guest, Wm. Pentony, Joseph Bullock, Edward Fisher, James Morrisby, and James Belbin. The only stipulation they made was that they should be allowed to wait until their crops were ripe, so as to take with them their corn and maize, and not be wholly dependent on rations from the public stores.

But the settlers soon repented of their hasty decision. When the *Integrity* arrived from Sydney a fortnight later (4th August) with further despatches from the Governor, and their contents were communicated to two of the principal inhabitants, out of the 41 who had sent in their names all but 10 withdrew. As the settlers would not move voluntarily, and as King had no instructions to use compulsory measures, the only thing left to do was to reduce the establishment. Foveaux was of opinion that such half measures were a mistake, and that the choice lay between continuing the colony on its existing footing or abandoning it altogether. To cut down salaries and discharge officers would work great injustice to men who had spent considerable sums in building houses and making improvements. They must be compensated, and the saving effected would be minute. But, indeed, any material reduction would be impossible. Courts of justice must be kept up, and there must be a sufficient number of officers to make a jury. Governor King proposed sending a vessel annually with officers to make a court, the vessel to bring back salt pork for the supply of Port Jackson. But a court once a year was quite insufficient, and their experience of salting pork was not encouraging. The pork was often so badly cured that it was useless for food, and the supply of swine could not be depended on. Corn was absolutely necessary both for their rearing and fattening, and the frequent scarcity of corn caused great mortality. Indeed, the expectations formed of the island were never likely to be realised. In 1801 there had been a famine owing to the scarcity of grain and pork, and the inhabitants had been dependent for food on fish. In 1802 the crops were better, but since then they had either failed generally, or had been so poor as hardly to reward the settlers' labour. But for the large yield from Government land in 1802, large supplies would have been required from Port Jackson. As it was, they had been obliged to get flour from Sydney, and even then could only allow a reduced ration. Many of the settlers were in great distress, and if the crops failed again—as indeed was afterwards the case—they would be in absolute want.

Yet in spite of all these disadvantages many of the settlers, especially those who had come over with the first settlement, showed a great reluctance to move. They were attached to their homes, and did not care again to face the difficulties and privations which they would have to encounter in a new settlement before they could get round them even such comforts for their families as they had at Norfolk Island. If they knew that the Government meant to abandon the settlement altogether, probably they would be willing to remove. One of the greatest obstacles was their debts. But perhaps the offer of greater inducements might overcome their reluctance, and eventually they would all benefit by the change.

Governor King had no authority to abandon the settlement, and was probably only too pleased that the settlers whom he had planted showed such an attachment to his favourite island, or at least so much reluctance to leave it. It only remained for him to make such reductions in the establishment as were possible. Some of the civil officers were discharged and others transferred to Port Dalrymple, the military guard was reduced by one-half, and most of the convicts were withdrawn, some being removed to Port Dalrymple and the remainder to Port Jackson. With the few small vessels available for the service, the difficulty of approach to the island, and the storms which on more than one occasion disabled the badly found and unseaworthy ships, the removal of even a small part of the people was a tedious business, extending over many months. By the end of 1805 about 250 people had been removed, leaving more than 700 still on the Island. The stores were for the most part transferred to Port Dalrymple and the Derwent. A large quantity of the salt pork sent to the latter settlement was condemned as unfit for human food.

In accordance with Lord Hobart's instructions, Major Foveaux resigned his charge on 12th February, 1805, when the reductions began. Captain John Piper, the senior military officer, took his place as Commandant. If Holt is to be trusted, Captain Piper's rule presented a favourable contrast to that of Foveaux, both in the humanity and consideration he showed to those under him and in his general conduct. To Piper was left the troublesome and unpleasing task of superintending the removal of the settlers. With but few exceptions they obstinately refused to stir. The first to leave were five settlers who sailed with Foveaux to Sydney, and thence proceeded to Paterson's Settlement at Port Dalrymple, where they arrived in April, 1805. These were the first Norfolk Islanders to settle in Van Diemen's Land. Paterson wanted them to take up their locations on the Supply River on the west bank of the Tamar; but they chose their allotments on a creek two miles south-east of York Town. The soil on the hills was bad, the flats were liable to floods. Their crops turned out so poor that they threw up their locations, and Paterson eventually gave them fresh grants in the fertile country on the banks of the South Esk, somewhere in the neighbourhood of

Longford. Seven months later two more of the Norfolk Island settlers found their way to the banks of the Tamar.

With a disabled little warship and a couple of small schooners for his whole available fleet, King had to look for some chance private ship to remove stores and people from Norfolk Island. In September, 1805, the *Sydney* arrived at Port Jackson from India. As she was bound to the Derwent for oil, King agreed with Captain Forrest to touch at Norfolk Island on the way and take a cargo to Collins' settlement. For this charter he paid the captain £600. He had by this time relented of his harshness to Holt, and given him permission to leave his place of exile, so that when the *Sydney* sailed from Norfolk Island on the 1st of November, Holt took a passage in her and paid a visit to the new settlement of which he has left us a lively account in his journal. In the *Sydney* also there came the first Norfolk Island settler to the Derwent—George Guest—who brought a wife and six children and also 300 ewes, of which only 265 survived the three weeks' passage. Of 200 ewes belonging to Government, shipped at the same time, only 148 were landed. Six head of cattle arrived safely.

Thus, at the end of 1806, after the exertions of more than two years, only eight settlers with their families had been prevailed upon to remove to Van Diemen's Land. The convicts had been nearly all withdrawn, the military guard reduced to 25 men, but there were still 700 people on the island, a number nearly equal to the combined population of the two recently founded settlements in Van Diemen's Land, viz., Hobart, 471; Port Dalrymple, 301; total, 772. Lord Hobart's despatch ordering the deportation of the settlers was dated June, 1803. If it had taken more than three years to move eight settlers, how long would it take to remove 700? The Colonial Office was beginning to grow impatient, especially as news had arrived that there was once more a bad harvest at Norfolk Island.

Accordingly, in December, 1806, the Secretary of State wrote a peremptory despatch on the subject to Governor Bligh, who had succeeded King as Governor of New South Wales. In this despatch Lord Norfolk recapitulated the reasons which had led Lord Hobart more than three years before to decide on the evacuation of the island. He remarked with dissatisfaction that the measures hitherto taken had had little effect in promoting the object of freeing the Government from the expense of an unproductive settlement; that it was plain that the crops were less satisfactory each year, while the expenses were ever increasing; that Port Jackson would soon be self-supporting, while Hobart Town and Port Dalrymple appeared to have everything to recommend them in regard to climate and fertility. It was now evident to the Government that no advantage could arise from the partial evacuation of Norfolk Island, and he therefore gave orders that measures were to be taken forthwith for the withdrawal of all settlers and stock and their removal to the new settlements in Van Diemen's Land, on the terms recommended by Foveaux nearly two years before, with certain modifications. The settlers were to be compensated for what they had to leave behind, the money compensation not to exceed £1000, and they were to have grants in the proportion of two acres only to one acre of cultivated land surrendered. On the other hand they were to have houses erected of value equal to those given up; were to be victualled for two years at the public cost; those of the better class were to be allowed the labour of four convicts for nine months and of two for fifteen months, those of less desert being allowed lesser privileges.

The deportation now began in earnest. H.M.S. *Porpoise*, the armed tender *Lady Nelson*, and the *Estramina* were to remove the people and their stock. Governor Bligh gave the settlers their choice between Port Dalrymple and the Derwent. Most of them chose the latter settlement. He then gave Collins notice to be ready to receive 120 settlers and their families, 386 souls in all, and at the same time sent him seven months' supplies.

The first vessel to arrive (28th November, 1807) was the armed tender *Lady Nelson*. She was already well known at the Derwent. In 1803 she had brought to Risdon a portion of Bowen's party, and had assisted at the founding of Hobart by Collins in February, 1804, and she now brought the first detachment of settlers deported from Norfolk Island. They consisted of 15 families, comprising 34 persons. Three months later (17th January, 1808) came the *Porpoise* with 43 families, altogether 187 persons, and on the 2nd March the *Lady Nelson* brought a further instalment of 50. Another three months saw the *Estramina* arrive with an additional 62. Thus in little more than six months Collins had had 330 people thrown on his hands with but little means to provide for their wants. Many of them were in a most wretched condition, and immediately applied to Collins for clothing and bedding which it was not in his power to give them. They had come with the expectation that all their wants would be provided for by the Government. All Collins could do was to billet the majority amongst the inhabitants. Some few he assisted to build houses for themselves. Some few he found sufficiently skilful to be employed at wages on the works he had then in hand, the principal of which was the large brick store which still stands at the bottom of Macquarie-street. Some of the new arrivals received their grants of land in the neighbourhood of the settlement at Sandy

Bay, but the greater part were fixed some 20 or 30 miles up the river, at a new settlement which, in memory of their old home, was called New Norfolk. The sudden accession of over 300 people to a small community which did not number 500 was a great strain on Collins' resources. His supplies were scanty enough, and when he learned that still more people were coming, and that he was to have thrust him upon more than double the number which Bligh had led him to expect, he was loud in his complaints both to the Home Authorities and to Sydney at the want of thought with which he had been treated.

In the meantime a little revolution had taken place in Sydney. Governor Bligh had been deposed by the officers of the New South Wales Corps, and the government had been assumed by Colonel Johnston. The work ot removal from Norfolk Island was then pushed on even more rapidly. Colonel Johnston chartered the *City of Edinburgh*, a vessel of 500 tons, to remove the rest of the settlers. The deposed Bligh, in his despatches to the Secretary of State, protested strongly against the folly of crowding a host of people into a settlement so ill prepared to receive them, a proceeding which must, he foresaw, involve the whole population at the Derwent in great distress.

Already there were loud complaints from the Norfolk Islanders of the hardships they had had to endure, so different from what they had been led to expect from the representations made to them when they left the island. Many of them were in the most destitute condition, and were glad to compound their claims against the Government by taking a few live stock as compensation for the houses and effects they had left. Probably, however, their own improvident habits were their worst enemy. Foveaux states that a ship named the *Rose*, belonging to Campbells, of Sydney, had touched at the Derwent on her way from England. In direct contravention of his orders from head quarters Collins allowed the Captain to land several thousand gallons of spirit for sale. He further permitted it to be sold to the new arrivals, who parted with their little store of salted pork to the Government store to raise money to purchase the spirits. Thus, many in a few days dissipated the whole of their small means of subsistence.

The *City of Edinburgh* sailed from Sydney to remove the rest of the settlers on the 26th May, 1808; she met with a succession of heavy gales, and was repeatedly blown off the island, so that she did not complete her loading for more than three months; she sailed from the island on the 9th September, carrying 226 people to the already overcrowded settlement at the Derwent, where she arrived on the 2nd October. The unfortunate people suffered much on the long voyage of nearly a month, and complained that they had been plundered on the way of much of their small property. The greater number were in a most destitute state—almost naked—and their arrival necessarily increased the prevailing distress at Hobart. The population of the settlement had been more than doubled by the 554 people who had come from Norfolk Island, and now stood at over 1000. Floods on the Hawkesbury in New South Wales had destroyed nearly the whole crops in March, 1808, and the Governor at Port Jackson could spare nothing in response to Collins' urgent appeals for help.

It is true that the Norfolk Islanders had brought some store of provisions, but a quite insufficient supply, and the Derwent settlement, as yet, produced practically nothing. In view of his probable necessities Collins some time before had made an agreement with Campbell, of Sydney, to bring him 500 head of Bengal cattle from India, but Lieut.-Governor Foveaux had set aside the contract as too costly, which was perhaps wise, as the shipment would have cost the English Exchequer some £20,000.

The Derwent settlement was now in great straits for food. The ration of salt meat had long since been reduced to one-half. There were only a few weeks' full rations in hand, and starvation was staring them in the face. Collins got some few stores from the rare vessels which touched at Van Diemen's Land, but this was a mere trifle. His only resource was to fall back on what the bush yielded. He therefore issued an order offering 1*s*. per lb. for all the kangaroo meat brought into store.

For the next year or two it was a struggle at Hobart Town for bare existence, and the people were on the verge of absolute starvation.

Lieut. Edward Lord, in his evidence before a Committee of the House of Commons in 1812, said that the whole settlement for a considerable time lived on kangaroo, not having a bit of other provisions. He says:—"During the great scarcity, when we lived for 13 months, except at small intervals, upon 2 lbs. of biscuit per week, we had not a single death. We were living on the wild game of the country. The people certainly suffered great inconvenience and very great privations from want of provisions. I have often myself been glad to go to bed from want of bread, and have often been without the little comforts of wine and sugar."

Kangaroo meat brought 1*s*. 6*d*. per lb. Later the *Sydney* was chartered to bring wheat from India, but she was wrecked. The *Venus*, Capt. Bunker, was then despatched. She was more fortunate, arriving in 1810 with a cargo of wheat, which at last relieved the inhabitants from their dread of famine. Wheat sank from £4, or even £6 per bushel, to 12*s*.

With respect to Norfolk Island, it was found undesirable, if not impossible, to abandon it entirely. There was still a herd of cattle and also some 3000 sheep which could not be at once removed. A small party was to be left to look after the stock and to try whether it was possible to cultivate coffee. Captain Piper reports, 30 Sept., 1808, after sailing of the *City of Edinburgh*, that there were still 250 persons on the island.

From the Report of the Parliamentary Committee above quoted it appears that in 1812 the Island was not wholly deserted. There were still a few settlers and some soldiers. A Return, dated 30 April, 1810, shows 98 free persons (of whom 61 were men) and 26 convicts, the military and officers numbering 53; total, 177.

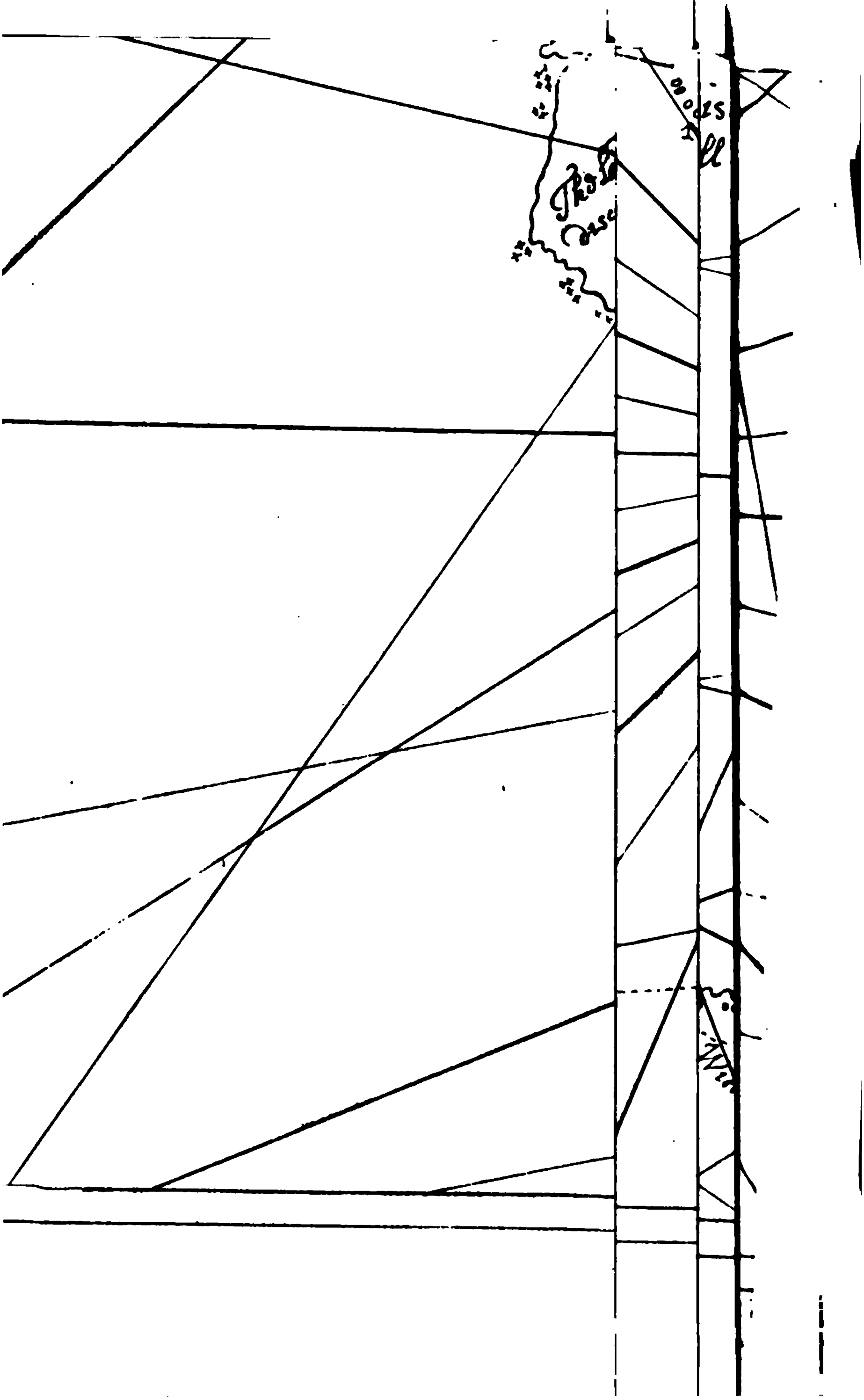
The settlers from Norfolk Island were given lands at New Norfolk and Sandy Bay, at Pittwater (Sorell), and Clarence Plains in the South, and at Norfolk Plains on the Northern side of the Island. These grants were at first small, seldom exceeding 40 acres. A certain proportion of the Norfolk Islanders—especially the marines and sailors who came out with Governor Phillip in 1788, and went to the island with King, and some of the crew of the *Sirius*—who had prospered in Norfolk Island, prospered also in Van Diemen's Land, and their families have continued to hold respectable and honourable positions in this Colony. But, as a rule, the Norfolk Island settlers did not add much to the welfare and progress of the settlement at the Derwent.

The great majority, idle and improvident in their old home, did not improve by removal. They were content to draw their rations from the stores so long as that privilege was allowed them, and then bartered away their grants for a trifle, to sink out of sight in poverty and wretchedness.

AN ACCOUNT of the Settlers, Free Persons, and Prisoners received into this Settlement from Norfolk Island from 29th November, 1807, to 1 October, 1808:—

Time received.	By what Conveyance.	Settlers and Free Persons.	Women.	Children.	Prisoners (Male.)	Total Number received.
Nov. 29th, 1807	H.M. Brig *Lady Nelson*	15	6	13	...	34
Jan. 17th, 1808	H.M. Ship *Porpoise*	56	39	76	11	182
March 1st „	H.M. Brig *Lady Nelson*	25	12	11	2	50
June 7th „	H.M. Colonial schooner *Estramina*	23	13	24	2	62
Oct. 2nd „	*City of Edinburgh*	83	39	96	8	226
	Total	202	109	220	23	554

LEONARD FOSBROOK, *Deputy Commandant.*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NOTE ON AN EARLY CHART SHOWING THE TRACKS OF TASMAN'S VOYAGES IN 1642 AND 1644.

(Diagram.)

By A. Mault.

(Read April 9, 1894.*)*

The Government of Tasmania very liberally caused to be photo-lithographed a *fac-simile* copy which I had made of a chart showing the tracks of Tasman in his two voyages of of discovery in the years 1642 and 1644. The chart copied is in the Sloane Collection in the British Museum, and is marked on the back "Bibl. Sloan. 5222, 12. N.W. Closet 16." It is evidently a manuscript of the latter half of the 17th century, and was certainly copied by an Englishman, and probably from the original chart of Francz Jacobsz Visser, the chief pilot on board the *Heemskirk* on Tasman's first voyage, and captain and chief pilot of the *Lemmen*, Tasman's flagship in the expedition of 1644. A reduced map from the same chart is given in Major's "Early Voyages to Terra Australis," published in 1859 by the Hakluyt Society.

The Museum chart is drawn on paper in black ink, now faded. After the chart was drawn (possibly since Major's map was published) some one has added blue chalk lines, connecting Tasman's discoveries in the south of Tasmania with those he made in New Guinea on the one side, and those of Peter Nuyts on the other. In the photo-lithographs these blue lines have come out black. "Abell Tasman's passage" is marked in pricked lines. That of the 1642 voyage begins at about the longitude of Cape Leeuwin and ends at the north of the island of Ceram, the last place mentioned in Tasmans' journal of that voyage. The track of the 1644 voyage begins at the south-western coast of New Guinea, and, missing Torres Straits, goes round the Gulf of Carpentaria and the northern and western shores of Australia to Endracht Land whence he returned to Batavia. In the pricked track of the first voyage no soundings are given, in that of the second the soundings are given along the part of the passage within soundings. I therefore think this chart is a copy of that made by Francz Jacobsz during this second expedition. And there are other circumstances substantiating this opinion, notably the inscription in the middle of the chart, to which I shall again refer.

The expedition of 1644 probably started from Batavia on the 30th of January in that year, and was expected to return, if the instructions were fulfilled, in July, but as no journal of the voyage has been yet discovered this chart and a few

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notes made by Burgomaster Wilson, in 1705, are the only particulars that we know about it, except the "Instructions" above mentioned, which were given to Tasman by Antonio Van Diemen, the Governor, and the Council of the Dutch East Indies, and dated at Batavia the 29th January, 1644.

With reference to the British Museum chart, of which I beg to present to the Royal Society the photo-lithographed *facsimiles*, Major says: "It bears no name or date, but is written on exactly the same kind of paper, with the same ink, and by the same hand as one by Captain Thomas Bowrey in the same volume, done at Fort S. George in 1687. It is observable that in the preface to a work by Captain Bowrey on the Malay language, he says that in 1688 he embarked at Fort S. George as a passenger for England, having been nineteen years in the East Indies continually engaged in navigation and trading in those countries, in Sumatra, Borneo, Bantam, and Java." Major goes on to say: "The twofold blunder, both as to fact and date, contained in the sentence in the middle of the chart—'This large land of New Guinea was first discovered *to joyne to yᵉ south land* by yᵉ yot *Lemmen* as by this chart Francois Jacobus, Vis. Pilot Major, Anno 1643'—is self-evidently an independent subsequent insertion, probably by Bowrey himself, and therefore by no means impugns the inference that the chart is otherwise a genuine copy."

When I saw the chart it was not bound in a volume, so I had no opportunity of comparing its paper, ink, and handwriting with those of the other chart referred to by Major, so I accept his opinion as correct that probably the copy was the handiwork of Captain Bowrey. But I cannot accept the statements that the chart bears no name or date, and that the inscription in the middle of it "is self-evidently an independent subsequent insertion." This second statement is, of course, necessary to support the first, as if the inscription is not a subsequent insertion the chart cannot be said to bear any name or date. So far from the inscription being self-evidently an independent subsequent insertion, I think the evidence all points the other way. The error in the date is no doubt the fault of Captain Bowrey, or whoever else was the copyist of the chart and translator into English of the Dutch inscriptions on the original, but I take it that the wording of it shows that it is a translation of the chief pilot's inscription on the chart he prepared and sent in as the official return to the orders of the "Instructions" with reference to discovering "whether Nova Guinea is one continent with that great southland." It is barely possible that Bowrey could have known of this instruction, which the original writer of the inscription must evidently have known to be the great object of the voyage of the *Lemmen* and her consorts.

The expedition of 1644, under the command of Tasman as commodore, consisted of the yacht *Lemmen*, with a crew of 45 sailors and 11 soldiers, under the subordinate command of skipper chief pilot Franz Jacobsz Visser; the yacht *Zeemeuw*, with 35 sailors and six soldiers, under the command of Skipper Dirk Cornelisz Haan; and a smaller yacht as tender, the *Brak*, with 14 sailors, under the command of Skipper Jasper Jansz Koops. The yachts were plentifully provisioned for eight months. The instructions issued to Tasman, which were discovered at Batavia, and published a little more than a hundred years ago by Dalrymple, constitute a very remarkable document, and exemplify the prescient spirit of the leaders of Dutch East Indian enterprise, for had Tasman succeeded in fulfilling them he would have anticipated by nearly 130 years Captain Cook's Australian discoveries, and by about 150 years those of Bass and Flinders.

The instructions begin with a recital of all the Dutch expeditions that had made any discoveries in connection with the great southland prior to Tasman's voyage of 1642, concerning which voyage they say simply—"It is unnecessary to relate more here, as you are perfectly acquainted with all particulars." They thus record the discoveries made by the yacht the *Duyfken* in 1606, on the east side of what we now call the Gulf of Carpentaria; of D'Edel's Land in 1617, on the west coast of Australia; of Endraght Land further north in 1618-1622; of Arnhem's Land on the west side of the Gulf of Carpentaria in 1623; and of Peter Nuyt's Land on the south coast in 1627. It will be noticed that the discoveries above-named, together with the lands discovered, or seen, by Tasman in his two expeditions, are the only lands shown on the chart, and to this fact I shall refer further on.

The instructions then proceed thus:—"But to obtain a thorough knowledge of these extensive countries, the discovery whereof has been begun (in consequence of the intention of the Company and the recommendation of our masters), [there] now only remains for the future [to find out] whether Nova Guinea is one continent with that great southland, or separated by channels and islands lying between them; and also whether that New Van Diemen's Land is the same continent with these two great countries, or with one of them; or, if separated from them, what islands may be dispersed between Nova Guinea and the unknown southland, when, after more experience and knowledge of all the said known and unknown countries, we shall be better enabled for further undertakings."

Then follow the actual instructions as to what Tasman was to try to do. He was to make his way by the islands in the Banda Sea, Teninber, Key and Aroum (marked T. Acaga on the chart) to False Cape, which was then thought to be part of New Guinea, and is in 8 deg. south latitude. Thence he was to sail along the south coast of New Guinea till he reached 9 deg. of south latitude, where there was a large cove, which might be the opening into the South Sea. Into this he was to send the tender, the *Brak*, for two or three days to try and find a passage. If one were found he was to follow it until he reached the furthest known discovered land of the east coast in 17 deg. of south latitude (? 7 deg.), and then follow the trend of the coast eastward and southward as it might run until he reached his own discovery of the New Van Diemen's Land. Thence he was to go north-westwards to the islands of S. Peter and S. Francis lying off Peter Nuyt's Land, and try and find another passage between them and the southland eastward into the South Sea again. If this other passage were discovered he was to return by it to S. Peter and S. Francis. In any case he was to return from these islands by the south and west coasts until he reached Wilhelm's River between Endraght Land and De Witt's Land in 22 deg. south latitude, "when the known southland would be entirely circumnavigated and discovered to be the largest island of the globe."

We all know that the fulfilment of these instructions is quite feasible. The "large cove in 9 deg. south latitude and to the south-west of False Cape is the western part of Torres Straits, and the pricked line of Tasman's passage shows that he passed near to the entrance of Endeavour Strait, between the Prince of Wales Island and Cape York, by which Captain Cook entered Torres Straits in 1770. It is at least singular to note that the dotted line showing the edge of shoal water that is drawn across the cove is not also drawn across Endeavour Strait. And in the south, a course easterly from S. Peter and S. Francis would have taken Tasman past the Great Australian Bight and through Bass Straits. We shall probably never know whether Tasman did send the *Brak* into the cove or strait to report, and if he did why the passage through was not discovered. All that we know is that he did not pass the strait, but instead of doing so fulfilled the alternative course pointed out in the instructions. Before finishing with this part of my subject, I cannot forbear from again calling attention to the prescience of the Dutch authorities in having in the manner mentioned thus indicated the real position of the straits that give passage to the north and south of Australia from the Indian Ocean to the great South Sea, as they certainly knew nothing of what Torres had done. Fifty years after Dampier still held to the opinion that there was a great intermediate passage something like that shown on medieval charts as running between Little Java and Great Java; and a hundred and fifty years after Flinders did not think a strait or, at least, a great river from a central sea quite improbable.

The alternative instruction to be followed in the case that no passage to the eastward was found at the great cove in 9 deg. south latitude is thus given:—"But if (as we presume) the land of Nova Guinea is joined to the southland, and in consequence is one continent, you will be enabled by the S.E. trade wind to run along the north coast from 7 deg. to 22 deg. south, and thus entirely to discover this land." It is evident from this that Van Diemen and his Council at Batavia thought that Arnhem's Land was an island, and that the western part of the northern shore of Australia trended westward from the southern end of the Gulf of Carpentaria to about North-West Cape in De Witt's Land and north of Endraght Land. On arriving at Endraght Land, Tasman was—time and weather permitting—to go on southwards to Houtman's Abrolhos and try to recover the treasure lost there in 1629 by the wreck of the *Batavia.* He was also to inquire after two of the mutineers of the crew of that ship, who had been marooned instead of being executed with their companions. It seems from the chart that Tasman did not go south of Endraght Land to fulfil these latter instructions. Probably the time he had taken to get round the gulf and then follow the coast of Arnhem's Land and De Witt's Land to his turning point at about 23 deg. south had pretty well exhausted his provisions and water. I cannot help thinking that the question of victualling his ships had something to do with the non-fulfilment of the instruction as to finding a passage through Torres Straits. The voyage that the fulfilment of that instruction would have entailed would have been one of at least 13,000 miles, and mostly in unknown waters, and without much sea room if coast charts were to be made. Judging from his previous voyage, this would have taken at least 13 months, and he had only eight months' provisions.

To revert to the chart, the sailing instructions given fully bear out with regard to what Tasman was to do what I called your attention to in connection with what had been previously done, namely, that the chart refers to only Tasman's expedition—that all the information given upon the chart is given in connection with or in consequence of the instructions. As this is so, I do not see how we can resist the conclusion that the Dutch original from which it was taken and translated was the work of Franz Jacobsz, Tasman's chief pilot on both of his expeditions, and that the inscription in the middle of the chart is a translation of Jacobsz's own writing. The material information upon which the chart is constructed was all in Jacobsz's possession, and in no other person's except Tasman's. That information was derived from three sources: First, from the records of the previous voyages referred to in the instructions; secondly, from the record of Tasman's expedition of 1642; and thirdly, from the records of the expedition of 1644. With regard to the first of these sources, the recital of the previous discoveries in Nova Guinea and the southland, and the instructions as to what was to be done in regard to connecting them could not have been understood, unless charts were furnished showing the relative positions, and from these charts the eastern side of the Gulf of Carpentaria, the north-eastern part of Arnhem's Land and De Witt's Land, Endraght Land, D'Edel's Land, Leeuwin Land, and Peter Nuyt's Land would be laid down. With regard to the second source of information, an examination of the chart will show that the original of it was made by some one who had access to not only to Tasman's chart but also to his journal of the voyage of 1642-3, as the notes made on the north coast of Guinea are similar to those contained in the journal. When all the information to be obtained from these two sources was laid down upon the chart it would be as complete as it now is with the exception of the new land discovered in the course of the voyage of 1644. And the coast line of this new land, and the pricked line of the passage made while discovering it, is all that Jacobsz refers to in his central inscription.

Another argument in favour of the inscription being a copy of Jacobsz's attestation of the chart, and not an independent subsequent insertion of Bowrey, is that the name of New Guinea is applied to the new discovered land. Very shortly after the expedition of 1644 the newly-discovered land was called New Holland, and if Bowrey had written an independent title to his copy he would probably have thus named it. Dampier, who was on this coast in 1688, and again in 1699, always calls it New Holland.

It is evident that the Dutch authorities made no secret of Tasman's discoveries on this voyage, but that charts of it were published, or at least allowed to be copied. It is probable that Bowrey was thus allowed to make the copy in the Sloane collection. Dampier had a copy with him during his expedition of 1699, when he was in command of one of the king's ships. It evidently was similar to the one before us, for he complains of Tasman's (Mr. Tasman he politely calls him) inaccuracies in latitude. He gives two latitudes from the charts he refers to, one being that of the Abrulhos, which he mentions as erroneously laid down at 27 deg. 28 min. south, and the other being the Archipelago, now called after Dampier, which he says Mr. Tasman lays down in 19 deg. 50 min. instead of 20 deg. 21 min. south. The chart before us gives the latitudes Dampier says are wrong, so he evidently had a copy of the same original. With respect to these latitudes, I may mention that in the case of the Abrulhos Dampier is wrong, but in that of the Archipelago he is right.

I have referred to the prescience of the Dutch authorities in geographical matters as shown by the "Instructions." The instructions also illustrate their—shall I politely call it their keenness? in trading matters. Tasman is told when "shewing the samples and goods, you and the junior merchants are carefully to remark what goods the strange nation most esteem, and to which they are most inclined; likewise inquire what merchandise and goods they possess, particularly after gold and silver, and whether these metals are held in great esteem; to keep them ignorant of the precious value seem not greedy after it; if they offer to barter for your goods, seem not to covet these metals, but shew them copper, zinc, pewter, and lead as if these were of more value to us. If you find them inclined to trade, keep the goods which they seem most greedy after at so high a value that none may be sold or bartered without great profit." And so on.

To return to the instructions: If Tasman had fulfilled them and sailed round Australia and also round Tasmania, what would have been the result? Would Australian history have taken another course? I do not think so. The Dutch are a trading people rather than a colonising one. These expeditions of Tasman were solely for the purpose of opening new markets, and as they did not have that effect, on account of the low condition of the people, both in regard to numbers and attainments in the countries of the Australian continent and islands, they had no other effect. In due time the English entered into possession, and it is interesting to note how in the early days of their colonisation the claims of the Dutch were evidently admitted to the west or New Holland side of the continent, by limitations in the commissions of the Governors of New South Wales.

NOTES ON SOME TASMANIAN CHITONS.

By Mr. W. F. Bednall (Corresponding Member of the Royal Society of Tasmania).

(Read April 9th, 1894.)

Some time ago I received from Captain Beddome, of Hobart, several specimens of three species of Chitons, labelled respectively *Chiton speciosus*, *Chiton australis*, and *Chiton liratus*. At the time they came to hand the South Australian forms were engaging my attention, and I at once saw that there must be some mistake in regard to those sent under the names of *speciosus* and *liratus*, as they could not be made to answer the original descriptions of those species, but the difficulty of satisfactorily identifying them by reference to the literature at my command compelled me to put them aside for the time being. A few months since some Chitons collected by Dr. Perks at Port Elliot, Encounter Bay, were submitted to me for examination, when I recognised that they were identical with the specimens sent to me by Captain Beddome as *Chiton australis*, Sowerby, and I so labelled them; further, I exhibited an example before the Royal Society of South Australia as an interesting addition to the molluscan fauna of this colony. Having, however, since had the privilege of studying the exhaustive work of Mr. H. A. Pilsbry on the *Polyplacophora* (Chitons) as part of Tryon's Manual of Conchology, I found I had been too hasty, and had fallen into the too common snare of accepting a name under which a species is popularly known, and that, instead, the shell was the closely allied *Chiton novæhollandiæ*, of Gray. To satisfy myself more thoroughly I procured typical Port Jackson specimens of *C. australis* from Mr. C. Hedley, of the Australian Museum, while almost at the same time I received two examples from Mr. G. B. Sowerby, of London, labelled *C. australis*, one of which, however, proved to be *C. novæhollandiæ*, Gray. The means now being at my command, I resolved to deal with the forms received from Captain Beddome, and to submit the results to your Society. For the benefit of Tasmanian conchologists I shall quote the descriptions of the species from the Manual of Conchology very fully.

Ischnochiton haddoni, Pilsbry, 1892. Tryon's Manual of Conchology, Vol. XIV. (Polyplacophora) page 88, pl. 22, figs. 67-73.

Chiton longicymba. Sowb. Conch. Illust. f. 67.
" " Reeve. Con. Icon. species 163.

Lepidopleurus longicymba, Angas, in his Lists of the Mollusca of South Australia and of New South Wales, in the P.Z.S. of London.

Ischnochiton longicymba, Carpenter. MS.

" " Haddon, Challenger Report, Polyplacophora, p. 17.

Also *Chiton longicymba* of Australian collectors, but NOT *chiton longicymba*, Quoy and Gaimard. "Shell distinctly keeled on the back; *scales of the girdle beautifully regular in size and arrangement, and evenly and deeply grooved.* Sculpture and colour pattern like *I. longicymba.* Interior white, greenish, or bluish; anterior valve with 10, central 1, posterior valve 12 slits; teeth thin, sharp. *Posterior tooth of the intermediate valves long, extending almost to the posterior lateral angle of the valve, and not terminating abruptly.* Length 27, breadth 12 mill.

"The colouring is even more variable than in the New Zealandic *I. longicymba*; some specimens are clear, light greenish buff; some are brown, speckled all over with olive black; some are mainly red or black, having a wide white dorsal stripe."

Port Jackson, N.S.W., South Australia (common), Tasmania.

Mr. Pilsbry writes:—"Having examined extensive suites of specimens of the *longicymba* type from New Zealand and Australia, I find myself compelled to separate specifically those from the latter locality, although in general appearance, colour, and sculpture they certainly resemble the true *longicymba.* The differences indicated (in italics) seem to be remarkably constant and readily recognised if one takes the trouble to look for them. It must be admitted, however, that to thoroughly examine a small Chiton involves some little trouble; and therefore we must feel no surprise if the superficial collector, and the often no less superficial author, continue to confound species which are really distinct. It must be said, however, that the confusion of these two species has probably been due to the lack of specimens from the two localities for comparison, else the differences would hardly have escaped writers so careful and observant as Carpenter and Haddon."

I examined every specimen sent to me by Captain Beddome, and found that all belonged to the Australian *Haddoni*, and not to the New Zealand *longicymba.*

The foregoing species was received from Captain Beddome as *Chiton speciosus*, Adams and Angas. The *C. speciosus* was described in P.Z.S., 1864, p. 192, from specimens obtained by Mr. Angas on Yorke's Peninsula, South Australia. It is a synonym of *Chiton contractus*, Reeve, Con. Icon., species 78 (1847), the habitat given being New Zealand. *Ischnochiton contractus* is a common South Australian species, and is credited to Tasmania by Mr. Pilsbry on the authority of the Cumingian collection.

ISCHNOCHITON (ISCHNORADSIA) NOVÆHOLLANDIÆ (Gray MSS. in Brit. Mus.), Reeve, Con. Icon. Species 142 (1847).

Chiton (Lophyrus) australis, Sowerby. Tenison Woods Census of the Marine Shells of Tasmania (1877).

Received from Captain Beddome as *Chiton australis*, and also from Mr. W. Legrand under the same name over twenty years ago.

The following are the essential portions of the descriptions of the two species, transcribed from the Manual of Conchology :—"*I. novæhollandiæ.*—Shell oval-oblong, elevated, the dorsal ridge angular, side slopes nearly straight ; colour green, minutely marbled with olive, the lateral areas darker. Lateral areas sculptured with *low, uneven, somewhat nodulous radiating riblets, and some concentric growth wrinkles. Central areas smooth except for a very dense and regular microscopic granulation.* End valves having radiating riblets. Interior blue green, with pink and olive rays. Girdle covered with smooth, solid, pebble-like scales, which toward the outer edge are subcarinated. Length 43, breadth 23 mill. Adelaide, South Australia."

I may here state that there is no locality in the immediate neighbourhood of Adelaide where this shell is likely to be taken.

Encounter Bay, S.A. (Dr. Perks, Professor Tate.)

Tasmania, where apparently it is a common species.

"*I. australis.*—Shell oval oblong, moderately elevated, the dorsal ridge sub-angular, side slopes nearly straight. Colour dark olive brown, the apices of the valves pink when eroded. Lateral areas sculptured with *close uneven riblets, which usually bifurcate or branch freely, especially toward the posterior margin of the area. Central areas closely and evenly sculptured with finer longitudinal riblets,* obsolete on the ridge, where they give place to a dense microscopic granulation. End valves sculptured with close radiating riblets, those of the posterior valves irregularly granose. Interior light blue-green, with two wide pink rays in each valve, and behind them two olive-brown rays. Girdle wide, closely covered with conspicuous, convex, pebble-like scales, which toward the outer edge are subcarinated in the middle. Length 62, breadth 35 mill. Port Jackson."

Attention to the italicised words in the foregoing descriptions will show the outside difference existing between these two species, and a study of the specimens now at my command has satisfied me that the Tasmanian and South Australian shells are identical, and are *C. novæhollandiæ*, Gray, and not *C. australis*, Sowb., as given in Tenison Woods' Census of Tasmanian Marine Shells. Neither have *C. concentricus*, *C. muricatus*, or *C. smaragdinus* anything in common with the present forms, as suggested by Mr. Woods, the two former being true Chitons, and the latter a typical Ischnochiton as restricted. The Port Jackson specimens are typical *australis* in every particular. Of the Tasmanian shells I have six, and of the South Australian I have examined eight (a gradation of sizes in each case). In the most perfect of those from Tasmania there are superficial signs of the longitudinal riblets on the central areas at the extreme sides in front of the diagonal lines, as also are there on the two largest of the South Australian ones. I do not note any concentric growth wrinkles on the *C. australis* from Port Jackson, but they seem to be more or less present in the *C. novæhollandiæ* from both localities mentioned, in which also the radiating riblets of the terminal valves are more or less broken up into concentric granulations. The two specimens received from Mr. Sowerby are labelled "Australia," and comprise one of each species.

CHITON PELLISSERPENTIS. Quoy et Gaimard., Voy. de l'Astrolabe, Zool. iii., Moll., p. 381, t. 74, f. 17-22 (1834).

C. pellisserpentis, Reeve, Con. Icon., species 84.

„ „ Hutton, Cat. Mar. Moll, N.Z., 1880, p. 111.

"Shell oval, rather elevated, hardly carinated, the side slopes somewhat convex. Surface lustreless. Colour a rather dull and dingy olive or olive-green, marked with black along the ridge, and on the sides of some valves. The lateral areas moderately raised and sculptured with *three or four rows of distinct tubercles*. Central areas having *strong, irregular growth wrinkles, and fine longitudinal riblets*. Anterior valve larger and much more elevated than the posterior, both being sculptured with numerous regular rows of distinct tubercles, the rows increasing by splitting. Posterior valve depressed, the low mucro in front of the middle. Inside blue, indistinctly blotched with olive-green. Sutural plates rounded, the sinus broad and deep, smooth or hardly denticulate.

Anterior valve having 12, central valves 1, posterior valve 12 slits, teeth blunt, pectinated. Eaves broad. Girdle wide, *alternately light and dark;* scales rather large and wide, often showing a slight tendency to carination in the middle, microscopically striated. Length 30, breadth 23 mill. New Zealand."

It may be here mentioned that in order to satisfactorily determine a chiton by all its essential characters, which particularly include the internal ones, such as the sutural plates, sinus, slits, etc., it is necessary to take the shell to pieces.

Received from Captain Beddome as *Chiton liratus*, Adams and Angas, and under which name I am informed it is labelled in the museum collection at Hobart. *C. (Lepidopleurus) liratus* was described with other South Australian Chitons, including *C. (Lepidopleurus) speciosus* by Messrs. Adams and Angas in the P.Z.S, 1864, from specimens gathered by Mr. Angas on Yorke's Peninsula, S.A. I have not yet myself been successful in determining the *C. liratus* from among our South Australian Chitons, but at any rate no South Australian specimen of *pellisserpentis* exists in any local collection. Again, the Tasmanian shell is a true Chiton, whereas *liratus* of A. and A. is an Ischnochiton. In concluding that the Tasmanian shell is *C. pellisserpentis* and not *C. sinclairi*, which is closely allied to it, I have relied on the circumstance that in the specimens in my possession (five) the broad sinus shows an "absence or absolescence of teeth," and also on the colouring of the girdle, which is alternately light and dark. The figure in Reeve well illustrates the species.

Chiton sinclairi, Gray. Dieffenbach's Travels in New Zealand, Vol. 2, p. 263 (1843).

As this shell is closely related to *C. pellisserpentis*, and as it has been recorded from Tasmania, although that locality has been doubted by the late Rev. J. E. Tenison Woods, I have extracted the full description as given in the Manual of Conchology for the benefit of Tasmanian conchologists.

"Shell oval, rather elevated, the *dorsal ridge rounded*, side slopes rather straight; *brown-black*, each valve *irregularly and raggedly striped with whitish*; the head valve pale with dark rays. Sometimes the white predominates. The lateral areas are raised and sculptured with *three or four radiating granose ribs, often sub-obsolete*. Central areas *smooth in the middle except for a few growth wrinkles*, but having *fine short longitudinal riblets at the sides in front of the diagonal line*. These riblets are sometimes almost obsolete. Head valve sculptured at first with about 15-18 granose riblets, but as they have a tendency to split as the valve grows, the number in a grown specimen is usually 24-30. Tail valve having a low, obtuse mucro, decidedly in front of the middle. Interior bluish. Sinus rather wide, denticulate, the area behind it porous. Anterior valve having 11, central valves 1, posterior valve 14 slits; teeth obtuse, strongly crenulated. Eaves broad, spongy. Girdle covered with large convex scales, which are very finely, sharply striated. Length 28, breadth 18 mill. Another specimen length 17, breadth 11 mill."

Those portions of the description printed in italics emphasise the salient features of the species.

Mr. Pilsbry says:—"The smooth polished central areas, grooved only along the diagonal line at the sides, and the granose-ribbed lateral areas and end valves are characteristic. The black and white colouring is also constant. The sculpture of the side areas varies greatly in strength. This species has been reported from Tasmania, but on doubtful authority."

The *Conchologia iconica* (Monograph of Chiton, published in 1847) gives "Van Diemen's Land" as the habitat of this shell on the authority of Dr. Sinclair, R.N. Presumably, as this Chiton is named after Dr. Sinclair by Gray as a New Zealand species, the locality given by Reeve four years afterwards may be an error.

Reeve's notes to this shell in Con. Icon. is:—"Very closely allied to *C. capensis* and *C. pellisserpentis*, but distinguished from both by the peculiar structure of the granules, which, to use a mournful comparison, have an appearance like the nails on a coffin."

C. sinclairi is included in Tenison Woods' Census of the Marine Shells of Tasmania (1877), with the following remarks:—"A New Zealand shell, whose Tasmanian habitat is doubtful."

Turning to Professor Hutton's Manual of the New Zealand Mollusca (1880), when I had written the larger part of this paper, to read the description given by him of *C. pellisserpentis* I was astonished to find myself accredited as an authority (bracketed with Reeve) for giving Tasmania as a habitat for *C. sinclairi*. Although I have been in possession of a copy of this book from the time of its publication by the courtesy of Professor Hutton, I do not recollect having noticed this before. It must assuredly have been a *lapsus calami* on the part of the Professor (Beddome, no doubt, being intended), for I never possessed the species till about two months ago, when I received examples from Mr. G. B. Sowerby, of London, labelled "New Zealand."

C. sinclairi may certainly be looked for in Tasmania, although the affinities of the fauna of the island are with Australia and not with New Zealand.

NOTES ON A NEW SPECIES OF PEDALION FOUND IN THE SOLOMON ISLANDS.

BY V. G. THORPE, F.R.M.S., H.M.S. PENGUIN.

(Corresponding Member.)

(Read April 9, 1894.)

The paper I have the honour to read before this Society might be entitled, with some truth, "The History of a Lost Opportunity." In a paper which I read before the Royal Microscopical Society of London, in 1889, on a "New Species of Megalotrocha," I spoke of Dunk Island, off the coast of Queensland, as follows:—"One meets with a tiny pool, not more than three or four feet across, on the bleak and rocky headland of an island out at sea, exposed to the storm and to the glare of a tropical sun, breakers beating on the rocks below within twenty feet of it, and yet, strange to relate, I found the water of such a solitary and lifeless pool literally swarming with a wonderful pedalion." But at that time (1888) I did not realise that this rotifer was a totally distinct and new species. Last August (1893) whilst examining some water collected in the artificially hollowed-out trunk of a cocoanut tree, made by the natives of New Georgia for drinking purposes, and growing on a small island in Rendova Harbour, Solomon Islands, I once again came across this pedalion in considerable numbers. Then I recognised my old friend of the Australian coast, and realised that it was a new species, differing in essential details from the only known species of Pedalion, *P. mirum*. Before I could, however, complete my examination of this rotifer, the news arrived that this same species had been discovered by Dr. Levander, of Helsingfors, in Finland, in October, 1892,* and had been named by him *P. fennicum* four years after I first had seen it.

The genus "Pedalion" can with truth be regarded as one the great discoveries of the nineteenth century. As late as the year 1871, the true position of the Rotifera in the animal kingdom was a matter of keen dispute. At first classed with the Infusoria, they were afterwards raised by some observers to the level of the Crustacea, whilst others placed them among the Vermes (worms). In that year Dr. C. T. Hudson discovered in Clifton, England, a rotifer, for which not only a new genus had to be formed, but also a new family, whilst a new order was created for its reception as well as the reception of *Hexartura polyptra*, another extraordinary rotifer found in Egypt in 1853, but never seen since. This new rotifer, named by Hudson *Pedalion mirum*, resembled in its general conformation the Namplius larva of one of the freshwater Entomostraca. Not only did it possess, in common with other rotifera, a ciliary wreath on its head, by the movements of which it was driven through the water in a manner somewhat similar to that of the screw of a steamship, but it had in addition six limbs, which enabled it to skip several times its own length. Here then we have in Pedalion the connecting link between the two sub-kingdoms, Vermes and Arthropoda.

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*Curiously enough, like mine "in a little pool, about two yards square by a foot deep, ten yards from the sea-shore, and not a yard above the sea-level; no vegetation; grey detritus on the bottom; the water moderately clear; sweet."

For a long time England was Pedalion's only home. But it has since been found in several others parts of the world. I myself have come across it in China, the waters of which literally swarm with beautiful microscopic organisms, and also in the desolate volcanic island of Ascension in the middle of the Atlantic Ocean.

Now a second species of this wonderful genus has been discovered, mounted specimens of which are now under the microscopes on the table.

The differences between the two species are soon told. In size they are nearly equal, viz., about $\frac{1}{125}$ inch in length, though I think that the new *P. fennicum* is rather broader than *P. mirum*. If you will glance at the sketches of these two rotifera, you will see (marked *a*) two peculiar stylate processes projecting from the posterior end of the body of *P. mirum*; these are absent in *P. fennicum*. Taking into consideration the six limbs, the ventral limb (mark *b*) is seen to project considerably beyond the hinder end of the body in *P. mirum*, whilst in the new species it only just reaches beyond the posterior end, and is therefore considerably shorter. There is also a marked difference in the lateral limbs. In *P. mirum*, the dorso-lateral limb (*g*) is considerably smaller than the ventro-lateral limb (*j*), whilst in *P. fennicum*, the two lateral appendages are nearly equal in size. The bristled extremities of all the limbs, but especially the ventral limbs, are more expanded in *P. mirum* than in *P. fennicum*.

Such are the main differences. The internal anatomy, as far as is known (the digestive, nervous, water vascular, reproductive, and muscular systems), is similar in both species. Only females have been found at present, many of them bearing one or two reddish eggs attached to the hinder part of the body.

ANTARCTIC EXPLORATION.

By A. Mault.

(Read April 9, 1894.*)*

Antarctic exploration is no new subject for discussion at the meetings of the Royal Society of Tasmania. Our founder was the hero of Arctic research, and our records contain papers by another of our distinguished Fellows—the *facile princeps* of Antarctic explorers, Sir James Ross—of whose expeditions Hobart was the base of operations. In later times one of the best records of Antarctic exploration up to date is contained in the paper read before us in 1886 by the late Deputy Surveyor-General, Charles Sprent. That paper is so complete a history of what had been done that I should not have again called your attention to the subject but for the additional information that has lately been obtained in connection with voyaging among ice under conditions totally different to those under which Ross achieved so much. The information is derivable from papers that have been recently read, and discussions that have taken place upon them at the meetings of the Royal Geographical Society and the Royal Scottish Geographical Society. I need hardly say that the new conditions under which voyaging among ice floes and bergs is being done are those connected with the use of steam.

Up to the present time no properly equipped and constructed steam vessel has crossed the Antarctic circle. The *Challenger* is the only steam vessel that has crossed the circle; and, as she was not intended for service in high latitudes, she was wholly unprotected for ice work. But the experience gained by the Dundee and Norwegian steam whalers during the 1892-93 season in the neighbourhood of Graham's Land and the South Shetlands, just north of the Antarctic circle, show very clearly under how much more favourable conditions Antarctic research can now be undertaken than when Cook and Weddell and Ross penetrated beyond the 70th parallel of south latitude.

Here is Ross's account of how he had to encounter a storm in the ice on January 19, 1842:—"At 9 p.m. the wind suddenly freshened to a violent gale from the northward, compelling us to reduce our sails to a close-reefed maintopsail and storm staysails: the sea quickly rising to a fearful height, breaking over the loftiest bergs, we were unable any longer to hold our ground, but were driven into the heavy pack under our lee. Soon after midnight our ships were involved in an ocean of rolling fragments of ice, hard as floating rocks of granite, which were dashed against them by the waves with so much violence that their masts quivered as if they would fall at every successive blow; and the destruction of the ships seemed inevitable from the tremendous shocks they received. By backing and filling the sails, we endeavoured to avoid collision with the larger masses, but this was not always possible; in the early part of the storm the rudder of the *Erebus* was so much damaged as to be no longer of any use; and about the same time I was informed by signal that the *Terror's* was completely destroyed, and nearly torn away from the stern post. We had hoped that, as we drifted deeper into the pack, we should get beyond the reach of the tempest; but in this we were mistaken. Hour passed away after hour without the least mitigation of the awful circumstances in which we were placed. Indeed, there seemed to be but little probability of our ships holding together much longer, so frequent and violent were the shocks they sustained; the loud crashing noise of the straining and working of the timbers and decks, as she was driven against some of the heavier pieces, which all the activity and exertions of our people could not prevent, was sufficient to fill with dismay the stoutest heart that was not supported by trust in Him who controls all events; and I should commit an act of injustice to my companions if I did not express my admiration of their conduct on this trying occasion; throughout a period of 28 hours, during any one of which there appeared to be very little hope that we should live to see another, the coolness, steady obedience, and untiring exertions of each individual were every way worthy of British seamen. The storm gained its height at 2 p.m. when the barometer stood at 28·40 inches, and after that time began to rise. Although we had been forced many miles deeper into the pack, we could not perceive that the swell had at all subsided, our ships still rolling and groaning amidst the heavy fragments of crushing bergs, over which the ocean rolled its mountainous waves, throwing huge masses one upon another, and then again burying them deep beneath its foaming waters, dashing and grinding them together with fearful violence. The awful grandeur of such a scene can be neither imagined nor described, far less can the feelings of those who witnessed it be understood. Each of us secured our hold, waiting the issue with resignation to the will of Him who alone could preserve us and bring us safely through this extreme danger; watching with breathless anxiety the effect of each succeeding collision, and the vibrations of the tottering masts, expecting every moment to see them give way, without our having the power to make an effort to save them."

Compare with this the following extracts from a paper read at the Royal Scottish Geographical Society's meeting at Edinburgh, in January of this year, by Mr. W. S. Bruce, naturalist to the steamship *Balæna* during the expedition of

1892-3 :—"Like our predecessors, we found it to be a region of gales and calms—gales from the north, with wet fog; gales from the south, with blinding snow; calms with fog, and calms with brilliant sunshine." Then, after giving a glowing description of a beautiful Christmas eve, he proceeds :—"This is the picture of a calm midnight in midsummer, different, indeed, from the heavy weather we experienced at other times, when for days we sheltered behind bergs and streams of pack during black nights thick with fog and snow. One of the gales we encountered the skipper described as the hardest that ever blew in the Arctic and Antarctic; and, indeed, it was stiff. For ten hours we steamed as hard as we could against it, and at the end had made only one knot. Picture to yourselves a sailing vessel: What a different agency we have now! Where Cook, Ross, Weddell, and others would have been in the greatest peril, we with steam were comparatively safe."

And Dr. Donald, of the same expedition, after referring to Ross's experiences of storms in the stout old *Erebus* and *Terror*, speaks in terms similar to those of Mr. Bruce as to the changed conditions due to steam.

But it is not only with regard to safety in storms that the use of steam has altered the conditions under which Antarctic exploration can be undertaken, it is a yet more important factor in connection with the power it gives to take advantage of opportunities and to contend with circumstances. Polar navigation, and especially Antarctic navigation, is the subject of what, until we know more of the laws that govern seasons and climatic and other conditions that affect it, we must call luck or good fortune. For instance, in 1823 Weddell found a clear sea which enabled him to push his little cutter to the 75th deg. of south latitude, four degrees farther than the limit fixed by Cook when he said, "I can be bold enough to say that no man will ever venture farther than I have done." And yet when Ross with his well found ships tried to surpass Weddell, he could on the same longitude get only to the 65th parallel. And again in 1841 Ross entered the main pack south of Campbell Island at the 67th parallel of latitude and got through it in four days. The next year he encountered the pack in 61 deg. 15 min., and it took him forty-four days to get through it. Now amidst all this uncertainty as to the conditions in which the polar ocean will be found there can be no doubt Ross did all that a skilful and daring seaman could do with the means at his command, and it is beyond all praise that he did so much. But what if he had had steam power? During all that terrible gale in the pack he so wonderfully describes in the extract I have given, the S.S.W. wind was driving him, together with the pack, back to the northward. If he could have done what the *Balæna* did last year, and held his own, the pack would have soon drifted past him. At the discussion on Dr. Murray's paper on Antarctic exploration read at the Royal Geographical Society's meeting on the 27th November last, Sir R. Vesey Hamilton said that with a steamer Ross's forty-four days in the pack would probably have been reduced to four. And he went on:—"I believe now that the amount of work that was done by Sir James Ross in three seasons could be done in one season with modern steam power, and I have some knowledge of ice navigation, having been three winters and five summers in the Arctic regions. Now the greatest enemy to a sailing ship is a gale in the ice heavily packed, as we have seen from the diagrams; then the ships are in great peril, perhaps for steam as well as sailing ships; but after the gale comes a calm, when the ice opens out and the steamer would immediately make rapid progress, while the sailing ship might be unable to move for some days."

And it is not only in cases like these mentioned by Sir Vesey Hamilton, that sailing ships are at a disadvantage. The readers of Sir James Ross's account of his voyages will come over and over again to passages describing how calms and contrary winds or currents baffled the great navigator at most critical times when a coastline had to be left unexplored or an opening in the ice left unentered. Had it been possible to have taken advantage of these lost opportunities, how much might the bounds of our knowledge of Antarctic regions been enlarged.

I have shown on the accompanying chart what, with regard to certain subjects, are the bounds of our present knowledge of those regions. It is based on information given in Dr. Murray's charts—our greatest authority on the subjects referred to. As regards the conformation of the coasts of Antarctic land or lands, what is known is distinguishable from what is hypothetical by difference of shading; and sources of the knowledge are shown by the tracks of all navigators known to have crossed the Antarctic Circle. Their voyages are well summarised in Mr. Sprent's paper recorded in our transactions. The chart also shows the bathymetric curves, and the summer temperature curves of the circumpolar ocean and air—important factors in relation to Antarctic exploration.

With respect to what has already been done in Antarctic regions by far the most important performances were those of Weddell in 1823, and of Ross in 1841 and 1842. Weddell's track, between 30 deg. and 40 deg. of west longitude, traverses the deep basin of the South Atlantic, and he did not get much beyond the 2,000 fathom curve. The relatively warm water that exists in the deeper parts of the Antarctic ocean probably accounts for the open water Weddell found. Sir

James Ross describes the upthrow of this warm layer of water caused by the southerly submarine current from the tropics meeting the gradual rise of the sea bottom as it approaches land. And Dr. Murray, in the paper already referred to, says that "these deep layers of relatively warm water appear likewise to be slowly drawn southwards to the Antarctic area, to supply the place of the ice-cold currents of surface water drifted to the north. This warm underlying water is evidently a potent factor in the melting and destruction of the huge table-topped icebergs of the Southern Hemisphere." The difference between the temperature of the surface and underlying water in the deep basin crossed by Weddell is shown by Ross's sounding in it when he reached no bottom with a 4,000 fathom line, and when with a surface temperature of the water of 30·8 deg. he found a temperature of 39·5 deg. at 1,050 fathoms—the greatest depth to which he could trust his self-registering thermometers.

Ross's tracks within the Antarctic Circle in 1842 and 1843, between 170 deg. east and 160 deg. west longitude, took him across no such deep basin, for the soundings varied from about 1,600 fathoms on the Circle to 150 as he approached land. But the influence of the warm underlying current from the north was always noticeable, the temperature of 39·8 deg. being repeatedly found at 600 fathoms with a surface temperature below freezing point; and at his farthest south, with soundings of only 250 fathoms, the shoaling had brought the warmer water to the surface where its temperature was 32 deg. with a mean air temperature of 27 deg. The temperature of the sea at the bottom was 33·2 deg.

In a conversation I had the other day with Captain Pascoe, he incidentally mentioned another factor that may have much influence in keeping an open sea in the neighbourhood of Ross's tracks in 1841 and 1842. These tracks pass along what is probably the main line of the earth's volcanic and seismic action in the southern hemisphere—the line marked by the New Zealand volcanoes and Mount Erebus. Earth tremors would certainly do much to help forward the action of the water on the great ice barrier that guards the coast of Victoria Land.

It must always be borne in mind that our knowledge of Arctic regions enables us to predicate very little in connection with Antarctic. The circumstances of the two poles—and especially the meteorological circumstances—are so entirely, and, at present, so unaccountably, different, that reasoning from Arctic data is almost inevitably misleading with relation to Antarctic facts and conditions. All navigators who have been in both are continually recording how unlike the one polar region is to the other. Many of the meteorological conditions are, with our present knowledge, quite unaccountable. For instance, why should the barometric pressure be so much less in the south than in the north? There is probably half an inch of mercury of difference. The effects of this are very evident in the southern zone of south-westerly winds with rain and snow all round the globe, but what is the cause? Again, we have all read of the short but for the time genial summer of the Arctic regions—why is there none in the Antarctic? Ross, when close to the great Victoria land ice barrier writes:—"Gigantic icicles depended from every projecting point of its perpendicular cliffs, proving that it sometimes thaws, which otherwise we could not have believed; for at a season of the year, eqvivalent to August in England, we had the thermometer at 12 deg., and at noon not rising above 14 deg.; this severity of temperature is remarkable also when compared with our former experience in the northern seas, where from every iceberg you meet with streams of water are constantly pouring off during summer.

Another remarkable phenomenon connected with what should be the Antarctic summer is the very small range of the temperature both diurnal and seasonal. In Ross's book the abstract meteorological journals given show for January, 1841, a maximum daily range of 12 deg. Fah. and a minimum one of 1 deg.; and for February, 1841, a maximum daily range of 10·5 deg. and a minimum of 1·5 deg. And last year Mr. Bruce had similar experience in the *Balæna.* He says in the paper from which I have already quoted:—"The records of air temperature are very remarkable; our lowest temperature was 20·8 deg. Fah., our highest 37·6 deg.—only a difference of 16·8 deg. in the total range for a period extending slightly over two months. Compare this with our climate, wherein a single day and night you may get a variation of more than twice that amount. . . . The average temperatures show a still more remarkable uniformity. December averaged 31·14 deg. for 115 readings; January, 31·10 deg. for 198 readings; February, 29·65 deg. for 116 readings—a range of less than 1½ deg. Fah. From these records of temperature Mr. Bruce and Dr. Murray and other authorities think it very probable that there is a comparatively small range of temperature all the year round in Antarctic regions, and that the cold of winter would not be so terrible as is imagined by some.

The result of the great amount of precipitation taking place in the zone of low pressure and in a summerless climate, is that the whole coastline of land within the Antarctic Circle is covered with an icecap of enormous thickness. But from observations of the prevailing winds in the south polar regions, it is almost certain that the zone of low barometric pressure and its accompanying great precipitation does not extend to the pole. Dr. Murray, in the paper we have already quoted from, says:—"It is probable that about 74 deg. S., the belt of excessive precipitation has been passed, and it is even conceivable that at the pole precipitation might be very little in excess of, or indeed, not more than equal to, the evaporation." It is, therefore, very likely that instead of the thickness of the snow or icecap on the Antarctic lands being 10 or 20 miles as estimated by the late Mr. Croll, Dr. Murray's estimate of 1,800 feet as the maximum is nearer the truth, as this estimate slightly exceeds the calculated thickness of the greatest southern bergs and floating ice islands.

In consequence of this all-prevailing mantle of frozen snow, "no land animal and no trace of vegetation--not even a lichen or a piece of seaweed—has been found on land within the Antarctic Circle." The whalers last year brought back some fossils, probably from tertiary rocks, that "distinctly indicate the existence of more genial conditions within the Antarctic in past geological times."

But as Dr. Murray says:—"When we turn to the waters of the Antarctic ocean we find at the present time a great profusion of life, both animal and vegetable. During the *Challenger* expedition myriads of minute spherical tetrasporæ were observed to give the sea a peculiar green colour over large areas. Diatoms were frequently in such enormous abundance that the tow nets were filled to the brim with a yellow-brown slimy mass, with a distressing odour, through which various crustaceans, annelids, and other animals wriggled. . . . Occasionally vast quantities of copepods, amphipods, etc., were observed to give the ocean a dull red colour. . . . . These small crustaceans are in turn the chief food of the fishes, penguins, seals, and whales which abound in the waters of the great Southern Ocean." How abundant and varied the animal life of this part of the ocean is may be judged from the fact that Dr. Murray mentions that the *Challenger* trawl and dredge obtained from waters lying farther south than Tasmania 326 new species, and 119 new genera from depths varying from 1,260 to 2,600 fathoms, and that one-half of the new species and a quarter of the new genera were not obtained elsewhere.

Now what is to be done in the matter of Antarctic exploration? Dr. Murray answers:—"A dash at the South Pole"—(like that which Nansen is making at the North)—"is not what I now advocate, nor do I believe that is what British science at the present time desires. It demands rather a steady, continuous, laborious, and systematic exploration of the whole southern region, with all the appliances of the modern investigator. This exploration should be undertaken by the Royal Navy. Two ships not exceeding 1,000 tons should, it seems to me, be fitted out for a whole commission, so as to extend over three summers and two winters. Early in the first season a wintering party of about ten men should be landed somewhere to the south of Cape Horn, probably about Bismarck Strait, at Graham's Land. The expedition should then proceed to Victoria Land, where a second similar party should winter, probably in Macmurdo Bay, near Mount Erebus. The ships should not become frozen in, nor attempt to winter in the far south, but should return towards the north, conducting observations of various kinds along the outer margins of the ice. After the needful rest and outfit at the Falklands, or Australia, the position of the ice and the temperature of the ocean should be observed in the early spring, and later the wintering parties should be communicated with, and, if necessary, reinforced with men and supplies for another winter. During the second winter the deep-sea observations should be continued northwards, and in the third season the wintering parties should be picked up and the expedition return to England. The wintering parties might largely be composed of civilians, and one or two civilians might be attached to each ship ; this plan worked admirably during the *Challenger* expedition.

In the discussion which followed the reading of Dr. Murray's paper, and in which Sir Joseph Hooker, the Duke of Argyll, Sir George Nares, Sir R. Vesey Hamilton, Captain Wharton, Lord Charles Beresford, Sir Wm. Flower, and others took part, general agreement was expressed with Dr. Murray's plan of campaign, and much enthusiasm was shown. If any doubts were expressed about the commercial utility of such an expedition, none were possible as to the priceless advantages that would accrue to science from it. Its popularity would be immense both in the Navy and in the scientific world, and the difficulty of manning the expedition would only be the embarrassment of choice.

At the Royal Scottish Geographical Society's meeting in January, after papers by Mr. Bruce and Dr. Donald on the scientific results of last year's whaling trips to the South Shetlands, a resolution was passed to send a memorial to Government in favour of a national expedition.

I have purposely avoided saying anything directly bearing on the commercial aspect of the question as to the desirability of sending such an expedition, because I think that is not our business. Commerce can and ought to take care of itself. And if we as a nation only sent out expeditions where we were sure beforehand of success from a commercial point of view, no interest would have suffered so much as the commercial interest of the Empire. Thorough scientific exploration has usually been followed as a natural consequence by commercial development. In this case the scientific interests are so important as to fully justify their being regarded as of such national concern as to require a special expedition. The *Erebus* and *Terror* were fitted out virtually only to obtain information with regard to terrestrial magnetism—that science is now as much in need of further information as it was then. And all the other sciences I have incidentally mentioned are equally interested. And with reference to all these sciences, in addition to our general interest, we have in Tasmania a particular one especially in connection with terrestrial magnetism, for we could probably offer the nearest site to the south magnetic pole for a permanent magnetic observatory. I hope that in connection with the revived interest in Antarctic research, and perhaps in connection with the Leake astronomical bequest and our University, such an observatory may be re-established in Hobart as that which did such good work under Ross and his successors.

In conclusion, I may claim to be consistent with regard to my opinion that this work should be done by the Royal Navy. A year or two ago I had the honour to stand and vote alone in this room in opposition to a proposed subvention from the Australian colonies to aid Baron Nordenskjold's projected Antarctic expedition, on the ground that it was a national matter and should be undertaken by the Royal Navy. I think so still; but as I then explained I included in the Royal Navy the Australian contingent, and I hope that if one can be made suitable for ice work, one of the two proposed vessels will belong to the little fleet to which we all contribute.

BOTANICAL NOTES.

By L. Rodway.

(Read June 11th, 1894.)

In November, 1886, Mr. T. B. Moore drew our attention to what he considered a new Eucalypt that he had found growing on the sub-alpine range between New Norfolk and the Huon district. He described it, and named it after our greatly esteemed friend Baron Von Müeller.

The Baron had already had an opportunity of examining the plant, having found it some years previously towards the summit of Mount Field east. He did not consider it distinct, but thought it probably a lowland form of *E. vernicosa*, H.

The tree has probably a wide sub-alpine distribution in south-western Tasmania, as besides meeting with it in quantity in both localities named, I have found it extensively [illegible] the southern slope of Mount Wellington at

Page 51, line 30.—For coceifera, read *coccifera*.
" 54 " 34 and 36.—For pubeseous, read *pubescens*.

no doubt it has been confounded. The two trees can hardly be distinguished when seen together, and with *E. müelleri* the branches are very tough, so that it is most unusual to pick up broken limbs with inflorescence. With *E. urnigera* on the contrary the wood is brittle, so that at this time of the year the ground in such a forest would be comparatively strewn with its flowers. Another cause of the overlooking of *E. müelleri* by botanists is that its buds and fruit are practically exactly similar to those of *E. coceifera*, Hh., and till one was fortunate enough to secure flowers and detect the parallel anther-cells the distinctness would not suggest itself. Whatever the cause may be this tree, which is most distinct from any eucalypt but *E. vernicosa*, grows in quant[illegible] the side of the track below the Springs, attains a height of 200ft., and yet has barely attained the dignity of a name.

It remains still a matter of opinion whether the tree should be considered specifically distinct from *E. vernicosa*, H. Its close relationship is undeniable, but the fact that this tree appears to die out at a sub-alpine altitude, and the dwarf alpine *E. vernicosa* not appearing in localities where this is so common, would lend some weight in support of the trifling structural differences. Beyond the greater dimension of the tree the leaf is more oblique, longer proportionately, and the veins more regular and less oblique than in *E. vernicosa*, and the calyx and capsule are larger. But these differences are not more than could be reasonably expected from the greater vigour.

The wood is of a pale red colour, and rather heavy; of a close fibrous texture of great tenacity, and is commonly used for palings and shingles, but it makes excellent axe-handles, and would be very useful for all purposes where considerable strength and toughness were required.

Mr. Moore's description, though very lucid, does not include all one would wish, I therefore take this opportunity to describe it more fully:—

Eucalptus müelleri, T. B. Moore. A tree often attaining 200 feet. Bark scaly at the base, smooth above, glaucous, but becoming blotched with rufous green on prolonged exposure. Leaves alternate, petioled, slightly oblique, 3-5in. long, ovate to narrow, lanceolate, acute, margin crenate, veins obscure, rather numerous and oblique. Peduncles axillary about ½in. long, angled. Flowers sessile, normally 3. Calyx in the mature bud obscurely angled, 4 lines long, operculum rather flat to sub-conical, verrucose and umbonate. Flowering calyx turbinate, 3 lines diameter. Stamens 2½ to 3 lines long, anther-cells parallel. Fruit broadly turbinate, slightly angled, 4 lines diameter; capsules deeply sunk, the valves just reaching the top of the rim.

Mount Wellington, Mount Field East, Mount Geikie, about 1,500 to 3,000 feet elevation. Flowering in May and June.

In a paper I had the honour of reading before the Royal Society last year, in alluding to the varied forms assumed by *Actinotus bellidioides*, B., I referred to a form in my possession with divided leaves. Since that time my indefatigable young friend, Wm. Fitzgerald, has found this form in different places, and in all stages of development. Its distinct spreading habit, alternate and divided leaves and peculiarities of inflorescence maintain themselves even when growing with *A. bellidioides*, but it was only after mature consideration that Baron von Müeller, to whom it was submitted, consented to name it, which he did by giving it the name of its discoverer, T. B. Moore. The description has been left in my hands.

Actinotus moorei, F.V.M., a small tufted and creeping perennial, usually with procumbent leafless branches extending 1 to 3 or more inches, the leafy ends ascending. Leaves alternate 3-segmented, but the lateral segments usually more or less deeply cleft, each segment 2 to 3 lines long, lanceolate, acute; petiole slender, about 4 lines long, with a short broad sheathing base, clothed with white silky hairs. Peduncle terminal, from very short to 1½in. long, slender, hairy. Umbel about 2 lines diameter; bracts about 6, very shortly united. Flowers about 5, calyx-limb apparently always 4-lobed and shortly tubular above the ovary. Petals none. Stamens apparently always 2.

Mount Hamilton, Mount Reid, Mount Tyndall, Hartz Mt.

Haloragis heterophylla, Brogn. This plant appears to have escaped addition to our census, not so much from its rarity than from its likeness to its relatives. Its divided leaves has often placed it with *H. ceratophylla*, Endl. It differs in the leaf, however, from that species in these organs being opposite, and in the flower and fruit it is closely allied to *H. tetragyna*, R. Br.

I have specimens gathered near Evandale some years ago by Aug. Simson, and about two years ago by Wm. Fitzgerald near Campbell Town. It is also very common on the flats and banks of the Jordan above Bridgewater.

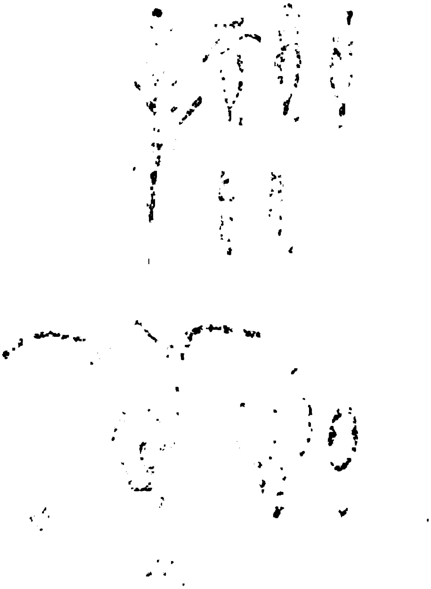
The genus Vallisneria is one that has always found great favour in the eyes of botanical students from the peculiarity of its flowers. The pistillate flower is solitary, and is developed on a long peduncle that is spirally coiled when young, but at maturity uncoils to allow the stigmatic lobes to be exposed at the surface of the water. The male flowers are extremely minute and numerous, and are formed on a rhachis within a spathe in the leaf-axils. When the buds are about ripe they escape from the spathe, rise to the surface of the water and there open. They float down the stream in great numbers, and generally some of them have the good fortune to meet the object of their being, the pistillate flowers. Vallisneria is distributed throughout the tropical and warm temperate portions of both hemispheres, and is generally considered to contain but one species, though an effort has occasionally been made to separate the Australian form as a distinct species. It would appear as though our Tasmanian plant at least had never received the fair treatment of being examined in the living condition, for the only descriptions I am aware of that passes to represent it does not accord with it. I am not disposed to take the responsibility of giving our plant a separate name, but for the sake of convenience and to mark its distinctness I will in describing it mark it as a variety.

Vallisneria spiralis, var. *procera*. Plant submerged, stoloniferous. Leaves 1 to 3 feet long, lin. wide, the margin thick obtuse, and often serrulate towards the apex. Male inflorescence on a very short peduncle in the leaf axils; spathe about ¾in. long, rather narrow, bursting into two valves or irregularly soon disintegrating. Flowers minute, very numerous on a slender rhachis nearly as long as the spathe, each flower on a slender deciduous pedicel, parting from the rhachis when mature, rising to the surface of the water and there opening. Perianth 3 lobed about ⅛ to ⅙ line diameter, the lobe not opposite a stamen narrower than the other two. Stamens 2, filaments combined in a very short column surrounded at the base by a ring of hairs, and bearing at the base two rudimentary staminodes. Anthers bilocular, but the walls destroyed upon dehiscence.

Female spathe about 1in. long, narrow, bursting as in the male, but rather more persistent, on a long peduncle that is usually but not always coiled when young. Ovary about 1in. long. Perianth lobes 3, broad, obtuse 1½ to 2 lines long, stigmas 3 broad, opposite the perianth lobes, each divided to the base. Staiminodia none. Capsule much enlarged, its peduncle not recoiling after fecundation in the very numerous plants examined.

Jordan River above Bridgewater. Flowering in February.

Stipa pubescens, R. Br., is one of our widest spread native grasses, and its variability is about as wide as its distribution. Its type and the forms running absolutely into *S. semibarbata*, R. Br., are well known, but we have a form common in dry, stony, hilly country that departs considerably in habit from any form I have seen described. The stems arise from a persistent hard slowly spreading base as we usually find in the type, but they are nearly glabrous, and develop no leaves beyond the sheaths, and the sheaths and their insignificant laminæ turn dry and pale as soon as elongated, giving the plant a very distinct appearance. The details of the plant otherwise do not differ from accepted forms of *S. pubesceous*, but its habit makes it sufficiently marked to warrant its being treated as a variety as *Stipa pubesceous*, var. *aphylla.*



Gaimardia fitzgeraldi, F. v. M. et R.

1. Natural size.
2. Flower head.
3. ,,
4. ,,
5. Upper bract.
6. Rudiment in upper bract.
7. Outer bract opened, upper bract removed to show flower.
8. Capsule.
9. Seed.

ON A NEW CENTROLEPIDEÆ.

By L. Rodway.

(Plate.)

(Read July, 1894.)

The small order *Centrolepideæ*, an offshoot of *Restiaceæ*, has its distribution mostly Australian. Tasmania is particularly fortunate in species numbering 12 out of a total of about 24 that have been described.

The order includes, according to the usually accepted classification, four genera: *Aphelia*, *Centrolepis* (including *Alepyrum*), *Trithuria*, and *Gaimardia*. Tasmania has long had recorded good specimens of the first three genera, and I have now the good fortune of adding a member of the fourth, *Gaimardia*, which has hitherto been found only in New Zealand and the South Seas to S. America.

The genus *Gaimardia* differs from *Centrolepis* in the carpels being placed on the same plane, and possessing two stamens.

I describe the plant in conjunction with our truly respected Fellow, Baron von Müeller, and we name it after its first discoverer, W. Fitzgerald, F.R.H.S.

Gaimardia fitzgeraldi, n. sp. A small perennial forming pale green densely matted cushions from a few inches to 2 feet, sometimes more scattered. Stems slender, 1-2in. Leaves numerous, sub-distichous, sub-erect, but spreading towards the tip; sheath stem clasping at the base only 2-3 lines long, with a tuft of woolly hairs at the junction with the lamina; lamina, ¼ to ½in. long, filiform, with a flat upper surface; the apex piliferous and hyaline. Scafes solitary in each year; lateral, or if terminal, soon thrust aside by an innovating shoot about ½in. long, slender. Lower floral bract, glabrous, about 1 line long, with an obtuse or toothed apex containing one flower. Upper bract rudimentary and bearing a rudiment. Scales none. Stamens 2, and alternating with the carpels. Carpels 2 in the same plane, connate. Styles free, diverging.

Mount Geikie, W. Fitzgerald. Adamson's Peak and range from Hartz to Mount La Perouse.

The plate is from fresh flowering specimens I procured on Adamson's Range.

FURTHER DISCOVERIES OF GLACIATION, WEST COAST, TASMANIA.

By T. B. Moore, F.R.G.S.

(Read August 14, 1894.)

Through the courtesy of Messrs. E. J. Dunn, R. M. Johnston, and A. Morton I have received the two former gentlemen's and Mr. Montgomery's papers of last year on Glaciation.

First I shall make a few comments on these papers, then relate my own experiences since writing on this interesting and important subject.

Both Messrs. Johnston and Montgomery take exception to my giving Mr. Dunn the honour of being the discoverer of land glaciation in Tasmania. I was quite aware that *evidences* of boulders, etc., transported by floating ice had been discovered, and surmises made that land glaciation had existed, but I still think that Mr. Dunn was (to use Mr. Montgomery's own words) "the first to bring forward *indisputable proofs*" of prehistoric glaciers, and this was my meaning when I wrote last year.

With regard to former discoveries enumerated in Mr. Johnston's list of "Principal Sources of Reference," I might rank as one of the early discoverers of *evidences*, although not mentioned in this list. For in 1883 I visited Lake Dixon, and also passed over Painters Plains, and was struck by the number of scattered granite and greenstone boulders and large boulders of the latter rock resting on the summit of Artist Hill and other prominent heights; also similar evidences all through the Collingwood Valley. Here the boulders were grooved, and the positions in which they were lying, "end on," pointed that they had been transported by the agency of glaciers from the Eldon Peak and Mount Gell. In my Government report, 1883 (and I believe 1886), which was printed and laid on the table of the House of Assembly, the above statement is recorded. In conversations I had about this time with my old friend Sprent and Mr. Johnston, I was under the impression that both concluded that the large boulders had been deposited by floating ice, and as late as 1889 Mr. Stephens, Director of Education, expressed this theory when asked by the Bishop of Tasmania, at Mount Arrowsmith, his opinion relative to the Collingwood boulders. Mr. Johnston's first paper with reference to erratics on Maria Island, brought by floating ice, was in 1884.

In 1887 another paper by his fluent pen is recorded, which I conclude would be written affer his trip in 1887 with Mr. C. P. Sprent and party along my track of 1883 and 1886, which at the time of their journey had for a great part of its distance been formed into a horse track.

It is on this journey, following on my footsteps four years later, that Mr. Johnston first finds his evidences of land glaciation at Lake Dixon, in the vicinity of Mount Gell. Being the first explorer in this direction to the West Coast, in all probability Mr. Sprent had one of my reports with him with remarks as to glacial action, as it was principally through his instructions as Deputy Surveyor-General I conducted my explorations. It was also after this trip that Mr. Sprent wrote his paper for the Victorian Branch of the Royal Geographical Society of Australasia, containing notes relative to glaciation in Tasmania. During this tour Mr. Johnston mentions that he spent three days in examining more particularly the rock formations on Mounts Owen, Lyell, and Sedgwick. This statement requires explanation, as it would appear that glacial action at that date had been found in the vicinity of Mount Sedgwick; to have reached Mount Sedgwick alone at that time four long days would be required to complete the journey there and back, therefore we must conclude our good friend had the use of a flying machine, or was mistaken in the mountains he visited.

With regard to the ancient glacial conglomerate, Mr. Johnston agrees with Mr. Dunn and myself that the conglomerates at Mounts Read and Sedgwick have originally been deposited under water by floating ice and belong to a very ancient epoch.

Mr. Dunn in his paper entitled "Glaciation of the Western Highlands, Tasmania" (in Proc. R.S. Vic., 1893), states with reference to the Mount Read conglomerate:—"There is a marked similarity in the nature of the cementing material and in the character of the embedded pebbles and boulders to the glacial conglomerate found at Wild Duck Creek, Victoria, and to the Dwyka conglomerate of South Africa, and they probably all belong to a very ancient epoch, either near the close of the Palæozoic period or else the commencement of the Secondary era." Mr. Johnston (page 35) says: "It is possible that some of the thick conglomerate beds occurring in the vicinity of Mount Tyndall, Mount Lyell, and Mount Owen* in which marks of ice action are reported to have been recently discovered by Messrs. Dunn and Moore may yet prove to belong to the same horizon" (Permo-carboniferous). The ice marks in the conglomerate beds at Mounts Read and Sedgwick may belong to the Permo-carboniferous period as Mr. Johnston surmises, but the boulders and pebbles in the recent moraines north of Lake Margaret and on the Linda Company's ground at Mount Lyell cannot be confounded with the ancient conglomerates, for the scored boulders are all of local origin, differing in character and form from the rocks of the ancient conglomerate; the scorings are also much deeper and decided in appearance. If parts of the older conglomerate had been disintegrated from the parent mass and become mixed with the recent morainal matter, the scorings would have been obliterated, for the best specimens from the ancient beds, bearing the deepest ice marks, are in rocks of a soft nature, though some of the harder ones are marked with very fine scratches.

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* Specimens with ice marks were sent from these conglomerates last year to illustrate my paper.

Mr. Montgomery in his able paper read last year, entitled "Glacial Action in Tasmania," remarks that I state Mounts Sedgwick and Dundas are capped with greenstone; he adds to these Barn Bluff, Mount Pelion, Mount Ossa, the Ducane Range, the Eldon Range, East Mount Pelion, and the Oakley Range as showing the same feature. The additions compose part of the great greenstone plateau of the centre of the island, or I should say a long offshoot of the same, dividing the waters of the northern and western rivers. This high dividing chain of mountains should not be confounded with the West Coast Range with its two isolated peaks of greenstone, Mounts Dundas and Sedgwick; except these and the schistose summits of Mounts Read and Darwin, all other eminences in the West Coast Range are capped with a quartzose conglomerate. In my paper I noted the peculiarity of these greenstone peaks as differing from the formations on the other heights of the range.

Mr. Montgomery found in his additions the columnar greenstone resting on the coal measures, which is a noticeable feature on the great greenstone plateau further south from his explorations, and surmises what he terms the moraine at Mount Sedgwick to be coal measures similarly situated. As we once visited Mount Dundas together, Mr. Montgomery is aware that this feature is not seen there, and when he has leisure to examine Mount Sedgwick, I do not think he will conclude that the greenstone rests on the *ancient glacial conglomerate*, but he will find rounded detached masses of the conglomerate resting on a porphyretic spur on the western side of the mountain, which have been disentegrated from the parent bed situated on the south-east side, and probably carried to their present resting places during the recent glacial epoch. He adds, "I cannot think it at all probable that Mr. Moore is correct in referring the conglomerate containing fossils to the action of floating ice. It seems more likely that it is a moraine drift derived from the lower beds of the carboniferous formation, which farther north, near Barn Bluff and Cradle Mountain, consists mainly of conglomerate. These would supply the stones, granite, slate, and porphyry, etc., which Mr Moore has noticed, and also the fossils, and I have little doubt when he comes to examine the country more thoroughly he will find these beds in situ under the greenstone capping. It is hardly conceivable that if the conglomerate was deposited by floating ice action in Permo-carboniferous times, which is what Mr. Moore's words seem to imply, that it should happen that the only proofs of such ice action should be found in a region where there has been evidently severe glaciation at a much later date. Before accepting such a theory, we should first have to eliminate all possibility of the conglomerate having been formed at the later period."

So able an authority as Mr. E. J. Dunn, F.G.S., who discovered a similar bed of glacial conglomerate between Moore's Pimple and Mount Read at an elevation of 3,000 feet, is convinced that it was deposited by floating ice in Permo-carboniferous times, and believes it to be identical with the conglomerates he has reported upon at Duck Creek, Victoria, and in Africa, and further on I hope to convince Mr. Montgomery that the above conclusions are correct.

Let us take Mr. Montgomery's theory "that it is a recent morainal drift derived from the lower beds of the carboniferous formation near Barn Bluff and the Cradle Mountain, which conglomerates would supply the granites, slates, porphyries, etc."

The Cradle Mountain, the highest elevation in Tasmania, is a little over 1,500 feet higher than the deposit at Mount Sedgwick, and if Mr. Montgomery had stated the height at which the lower carboniferous beds occur, it would have added more weight to his argument, and also shown if it were possible that the non-local rocks in the ancient glacial conglomerate at Mount Sedgwick could be derived from this locality, either *at an ancient* or more recent date of glacial phenomena. Besides, if this were a morainal drift derived from this distant locality, would we not expect to find some signs of the more elevated greenstone rocks in the shape of erratics and other non-local rocks on the high plateau round Mounts Geikie, Tyndall, Read, Sedgwick, and Murchison? besides the conglomerate would not be confined to two isolated spots. This would also apply to Mr. Johnston's suggestions that the glaciers may have descended from the great plateau, and that the arrow head of lineal direction of the general trend of striæ may be turned the other way. The question of the small collecting ground remaining above the ancient snow line is difficult to solve.

Is it not more probable that in the recent ice period the rivers of ice from the Cradle Mountain and Barn Bluff have flowed down and eroded the gorges of the Mackintosh and Murchison Rivers and their tributaries, which at the present time drain these high altitudes, than travelled over their deep-cut gorges a distance of forty miles, to the high land around the peak of Mount Sedgwick? and to substantiate this Mr. Montgomery says "there are grounds to believe that the Valley of the Mackintosh has been scoured out by glacial action." I now hope Mr. Montgomery will accept this theory, and eliminate all possibility of the conglomerate having been formed at the later period, for the only proof of such ice action *is not confined* to a region where there has been evidently severe glaciation at a much later date.

In the beginning of April this year (1894), while travelling from Zeehan to my old friend Sprent's top crossing of the Pieman River, I came across an extensive bed of a similar glacial conglomerate to that at Mounts Read and Sedgwick lying in a low basin-shaped valley about four miles north from the town of Zeehan, and west of the horse track leading to the punt placed on the Pieman River for the use of the Stanley River tin miners.

The bed, as near as I can approximately estimate, is about a mile long by a quarter of a mile wide, and appears of no great depth. I picked up numerous scored pebbles, but in the limited time at my disposal did not obtain any carboniferous fossils. Yet I feel positive they are to be found, for the rocks composing the conglomerate and the binding material are identical with those of the former discoveries of Mr. Dunn and myself.

The height of this bed is between three and four hundred feet above sea level, and if not formed by the agency of floating ice in the Permo-carboniferous age, Mr. Montgomery must allow that the recent glaciers have descended to a much lower level than he anticipated. Finding this extensive deposit at such a low altitude, far from any proofs of recent glacial action, and precisely similar to the other more elevated conglomerates at Mounts Read and Sedgwick, it is only reasonable to suppose that all belong to the same glacial age and method of deposit, as Mr. Johnston describes it, the ancient glacial epoch of Permo-carboniferous age.

In these notes I regret to have to dispute the theories of much abler men in the scientific world than myself, but what information I have gathered is from actual observation, and my records only embrace indisputable proofs of glacial action, which I trust will throw more light on the true aspect of this interesting subject.

In the beginning of July last year (1893) I had occasion to visit the western base of the Craycroft Hills, east of Macquarie Harbour; here I found a huge terminal moraine, containing boulders principally Devonian conglomerate, in size from the smallest atom to many tons in weight. The morainal matter is composed of rocks of a local origin, and all scored specimens picked up were undoubtedly so, the ice marks being as plainly visible as in the rocks of other recent moraine stuff in localities before enumerated. A small, turbulent, deeply-cut, precipitous stream runs parallel to the moraine, its bed being choked by huge rounded Devonian conglomerate boulders, forming miniature falls and blocks in the creek. The height of this interesting discovery above sea level is only 250ft, and without doubt the deposit has been brought by glaciers from the Craycroft Hills (named after a niece of Sir John Franklin) or Frenchman's Cap. The aspect of these hills, viewed in the distance, plainly shows that a great glacial erosion has scoured their slopes, although their present height cannot be more than 3,000ft. above sea level.

Mr. Montgomery in his paper remarks:—"I think we must come to the conclusion that the whole of the deep gorges among these western mountains now occupied by the head waters of the Pieman, Henty, and King Rivers have been at no very distant period of time occupied by rivers of ice;" and further on says, "If we allow this we must admit the ice came down to within 500 or 600 feet of the present sea level."

These conjectures are correct, for the moraines I reported finding in the King Valley in my supplementary notes last year are about 500 or 600 feet above sea level; and now we have a recent moraine in which indisputable proofs of glacial action exists at a very much lower altitude.

My last discovery is the most important and interesting of all, and will probably throw more light on the extent and age of our glacial action.

In the first week in June, 1894, the long promontory west of Farm Cove, Macquarie Harbour, forming the western boundary of that inlet was visited. Here I found a deposit of morainal matters containing boulders a quarter of a ton in weight. These masses covered the point, beach, and ran far out into the water. Where exposed to the present wave and tidal action all the finer markings and scorings were obliterated, but above and at high water level the ice marks are beautifully illustrated. (Illustrative specimens broken from the boulders, and boulders found at a later date are forwarded.) On my return, two months later, owing to high gales, I had to remain at this point, and spent a day and a half examining the locality. All round the promontory, and for a considerable distance on the Farm Cove side, the striations are really wonderful and many boulders are tons in weight; the largest measured was 15ft. long by 6ft. wide and deep respectively. Travelling five miles in a north-west direction past Phillip Island, along the present beaches the grooved and scored masses are scattered over the whole of that distance, and similar boulders, with the ice marks obliterated, are found extending far out into the waters of the harbour. Where the raised tertiary beaches have been denuded and now form the present sandy beaches the boulders on the land are covered from sight, but in the shallows of the shore they are plainly visible. The boulders rest on the lignite beds which have been denuded of their original overburden, but cannot be traced below the consolidated sand and fine clayey sedimentary cliffs. They are either exposed to all atmospheric influences or embedded in a recent earthy matter. On the eastern side of the point, the entrance to Farm Cove, a third of the way across is blocked even for navigation by small crafts by masses of boulders, rising in places above high water mark, and forming resting haunts for sea birds.

Let us follow the shores of the harbour past my recent explorations towards the coast to Sophia Point, or even to Strahan. Here we find boulders forming long points, in many places strewn over the present beaches or extending into the water, which if examined probably will prove to be ice-borne blocks.

Raised tertiary beaches enclose nearly all the north-eastern shore of the harbour, as it were, with a formidable wall of consolidated sand and mud. Nowhere do we find boulders in the consolidated mass, only on the unconfined points, heaped together on the narrow roadway at the base of the precipitous sandy cliffs jutting out into the water, or opposite the localities where the raised beaches have been cut out or almost wholly swept away, as at Kelly's Basin and at Farm Cove. On the summits of these sandy walls and all over the surrounding country what I now conclude is morainal matter extends to Mounts Sorell and Darwin ; for the large boulders we find could not have been so shaped, rounded, or deposited by any other means but ice. Travelling up to the valley between Mounts Sorell and Darwin the bed rocks of the creeks are worn smooth, and very little sedimentary material left in their courses. The valley is open, and ranges from 1,000ft. to 1,300ft. above sea level, is a mile broad and two and a half miles long, and has been swept clean of most of the morainal matter, leaving here and there huge, rounded, polished, and grooved boulders, in some instances as large as those described by Mr. Dunn as the Pilgrim, Traveller's, etc., in the Tyndall country. One monster measured 36ft. long, 24ft. broad, and 10ft. high.

The enclosing slopes and shoulders of Mounts Sorell and Darwin are all well rounded and in many places grooved, the grooves running parallel with the valley, indicating that a great stream of ice has flowed down the course of the Clarke River, located in the centre of the valley, smoothing the bed rock and carrying the debris brought from the surrounding heights into the lowlands. The smaller tributaries are like the larger streams cut down into the solid rock, and contain few traces of morainal matter in their beds. The soft schist and porphyritic rocks on the hummocky and flat rises at the head of the valley have their exposed surfaces worn smooth, and are overlaid with a thin coating of fragmentary ice-worn quartz, or have large erratics with perched blocks resting on their ice-worn summits. The river, after leaving the valley, takes a south-westerly course, and cuts through two large spurs, and in its now rapid course runs straight for Farm Cove, which beautiful inlet and its glaciated boulder promontory make a charming picture looking from the south end of the valley, the only portion of the harbour visible. After reaching the lower lands the stream turns to the eastward and runs in a sluggish course, emptying at last into Kelly's Basin. Rocks similar to those observed on the harbour can be obtained on the highlands, and it is reasonable to suppose they have been transported from there down the Clarke River gorge, seeing that the general tend of that stream is in the direction of the glacial point.

If we look at the precipitous south end of Mount Sorell, not more than three miles from Farm Cove, with its steep spurs running into the harbour, it is easy to suppose that if the glaciers have not descended to water level, that blocks of ice and ice-worn boulders may have been hurled into the harbour. From what I have observed I favour the opinion that the glaciers have travelled to water level, for we find spurs close to the shore of Kelly's Basin and Farm Cove stretching for two to three miles in the direction of Frenchman's Cap, Craycroft Hills, Mounts Sorell and Darwin, covered with morainal matter. These spurs or moraines are composed of a clay intermixed with pebbles and boulders, wholly different in composition and material to the sedimentary raised beaches.

I feel no doubt in my own mind that the pebbles and boulders are ice-borne, for we find in many cases two sides and an end planed, while other parts are rough, a noticeable feature in glaciated stones, compared with the rounded surfaces of those worn by water, indistinct scorings can be observed by a practised eye, to the sceptical perhaps they would not be distinguishable.

Mount Sorell is one of the highest prominences in the West Coast Range, and though we do not find the striæ and grooving on the rocks at such a high altitude as in the vicinity of Mount Tyndall, this would give a larger collecting ground above the ancient snow line, and seeing that the valleys have been worn and eroded to a greater extent at much lower levels, is it not more than probable that this higher eminence, the seat of prehistoric glaciers, standing, as it does, near the coast line, has let loose its glaciers, which have descended down the steep slopes with nothing to impede their course, and have tumbled into the waters of the harbour before melting ?

A connecting ridge, with grooved summit 1,700 feet high between the two mountains, divides the watershed of the Clarke and Garfield Rivers. The latter stream drains the north ends of the mountains, and is a tributary of the King River. The northern valley is at a much lower altitude (800 feet) and narrow, the gorges are more numerous, longer, and deeper cut. The rocks are all worn smooth, and in places grooved. An occasional erratic is seen, but little morainal matter left in the beds of the creeks, showing that the ice has travelled a considerable distance in this direction.

The principal gorges north and south of the ridge head from Mount Darwin, and the greatest waterflow at the present time comes from that mountain, whose summit I stated in my last year's supplementary notes has no signs of striæ, the rocks being rounded.

The low lying moraine, with its glaciated stones near the Craycroft Hills, conclusively proves that the ice has descended to much lower levels than anticipated by Messrs. Johnston and Montgomery, and the scored boulders near Farm Cove indicate, if not in a general way, in some cases the glaciers have reached sea level.

It is improbable that the boulders at Farm Cove are the results of icebergs in the Permo-carboniferous period, for it will be observed that the scorings on the illustrative specimens are well marked and clear, as if only scratched a few years ago, besides the boulders lie without surface covering, and their polished and scored surfaces have been exposed to all atmospheric influences, and in many cases to wave action. Such being the case, it is hardly possible that the ice markings would have remained so intact for so long a period, *i.e.*, since the Permo-carboniferous era.

If the scored boulders had been deposited by floating ice we would expect to find similar evidences in the tertiary beaches, which I need hardly say have been elevated since the ancient ice epoch ; this not being so clearly proves that our glaciers in some cases have descended to sea level. Also the non-evidence of any signs of ice action, except erosion in the palaeogene-lacustrine deposits at Macquarie Harbour will give a good proof as to the age of our recent land glaciation.

Before concluding, I might mention that in the beginning of 1893, during a tour down the coast south of the harbour, on the quartzite hills four or five hundred feet high, about two miles from and lying above the entrance to the harbour, I noticed the rocks very worn, smooth, and planed, and at the time felt convinced that it was by the agency of ice that the natural surface of the quartzite had been altered, though the positive proof of striæ and groovings was wanting.

It may be surmised that these planed surfaces and the deposits of glaciated boulders on the shores of the harbour are the results of stranded polar drift ice. If such was the case the ice drifts must have occurred before the elevation of the land and beaches, and if so we would obtain traces of glaciation in the palacogene deposits, which we do not. It may have been possible since the elevation of the land for drift ice to have been driven into the harbour through the entrance, but surely we should see some evidences of stranded bergs there.

The similarity in the composition of the scored boulders at Farm Cove is more puzzling to account for than any other feature in the matter.

I regret, through pressure of time, being unable to add a map of this district, for the charting on the large official map of the colony of Mounts Sorell and Darwin and the surrounding country is very incorrect, both mountains being mapped three miles too far to the eastward and not far enough south, besides other physical features being incomplete and wrongly depicted. In 1887 I corrected the errors on the Mines Office chart, and that map would give a better idea of this locality.

1894.

THE GOTHENBURG SYSTEM (Abstract).

By Russell Macnaughten

(Communicated).

NOTES ON SOME RIVER OUSE IMPRESSIONS (Abstract).

By Rev. C. W. H. Dicker.

TASMANIAN EARTHQUAKES OF 1892. (Abstract).

By Geo. Hogben.

MERIDIAN OBSERVATIONS WITH THE HOBART TRANSIT INSTRUMENTS.

By H. C. Kingsmill.

TASMANIAN TIMBERS, THEIR COMMERCIAL VALUE AND PREPARATION FOR MARKET (Abstract).

By A. Osborn Green.

ANCIENT WRECKS AND RELICS OF EUROPEAN VESSELS ON AUSTRALIAN COASTS (Title).

By J. R M'Clymont, M.A.

THE PROTECTION OF MUTTON BIRDS AND SEALS (Abstract).

By the Bishop of Tasmania.

EARLY VOVAGES TO PAPUA, 1511 to 1545 (Title).

By J. R. M'Clymont, M.A.

A NEW METHOD OF DROPPING THE TIME BALL (Abstract).

By Robert Henry.

PRIMITIVE THEORIES OF POLITICAL TEACHING (Title).

By Professor W. Jethro Brown, M.A., LL.D.

NOTES ON A RECENT TRIP TO THE HARTZ MOUNTAINS (Title).

By J. W. Beattie.

ABEL JANSZOON TASMAN:

HIS LIFE AND VOYAGES.

Read before the Royal Society of Tasmania, 25th November, 1895,

BY

JAMES BACKHOUSE WALKER, F.R.G.S.

PREFACE.

No life of the first circumnavigator of Australia has hitherto appeared in English. Nothing has been accessible to the English reader but an abstract of one voyage and a few lines in biographical dictionaries. This is scarcely surprising, when we consider how careless Tasman's own countrymen have been of his fame. Fifty years ago all that had been printed in his own country consisted of short abstracts of a few voyages, and these were hidden away in bulky collections. Even the date and place of his birth were matter for conjecture and dispute. Things are somewhat better now. Thirty-five years ago the complete journal of his famous voyage of 1642 was published in Holland, and we are now promised a sumptuous *fac simile* edition of the original manuscript, with notes by two eminent scholars, and with an English translation.

Moreover, patient searchers in the Dutch Colonial Archives have for years past been laboriously gleaning scattered particulars respecting him, and the results of their investigations have been printed from time to time in the transactions of Dutch learned societies, and in other places. It has thus become possible to piece together a fairly connected account of the great navigator's life.

But after all available information has been made use of, the result is disappointing. The man himself remains for the most part an indistinct figure. Personal details are few. The facts are mostly dry and meagre, gathered from formal official despatches and dusty registers. The material is wanting for a biography which would give a clear and sharply defined picture of the man as he lived.

It is possible, however, to attain what is of even more interest. We can arrive at a just estimate of his work as a discoverer, and of his place among the great navigators of the world. The discovery of Tasmania and New Zealand was no chance adventure. It was the result of a steady policy. It was the outcome of the adventurous energy which in the 16th and 17th centuries created the Dutch Republic; gave to Holland her Colonial Empire; and—not content with her possession of the Eastern Archipelago—sent out her sailors to search for a new world in the unknown regions of the mysterious South. Tasman and Visscher are but types of the men who won for their country her once proud position of mistress of the seas.

In the following pages an attempt has been made not merely to give all that is known of Tasman's life and work, but to present that work in proper historical perspective.

I desire to acknowledge generally my obligation to the authors whose names appear in the list appended to this paper, particularly to Messrs. Dozy, Heeres, Van Boekeren, and Leupe. Also to Sir Edward Braddon for his courtesy in having, when Agent-General for Tasmania, obtained for me valuable information from Holland. Especially to Mr. J. E. Heeres, of the Dutch State Archives at The Hague, for his generous kindness in placing at my disposal manuscript notes of his researches in the old Colonial Records—notes containing interesting details which have never before appeared in print. And, lastly, to the Treasurer, Sir Philip Fysh, for authorising the printing of this paper at the Government Press of the Colony. It is fitting that the first English biography of Tasman should be offered to Australian readers by the country which he discovered and which bears his name.

JAMES B. WALKER.

Hobart, January, 1896.

CONTENTS.

PAGE

INTRODUCTION 1

I. YOUTH AND EARLY VOYAGES, 1603–1638 6

II. VOYAGES IN JAPAN SEAS, &c., 1639–1642 11

III. THE GREAT DISCOVERY VOYAGES TO THE SOUTH LAND, 1642 AND 1644 :
  1. The Unknown South Land 17
  2. The Planning of the Great Discovery Voyage 25
  3. The Voyage of 1642 31
  4. The Voyage of 1644 35

IV. TASMAN'S LATER YEARS, 1644–1659 38

BIBLIOGRAPHICAL NOTES :
  Maps of the Voyages 44
  Manuscripts of the Journal 45
  Printed Works 46

APPENDIX : THE DISCOVERY OF TASMANIA (from Tasman's Journal) 49

MAPS.

MAPPE-MONDE, CIRCA 1630 19

(From the Atlas of Janssonius; Amsterdam, circa 1630.) Shows the Terra Australis Nondum Cognita, as supposed before Tasman's discoveries. [See page 19 of the text.] The figures in the border of the map represent: (1) The Seven Planets. (2) The Seven Wonders of the World. (3) The Four Elements. (4) The Four Seasons.

MAP OF TASMAN'S VOYAGES, 1642 AND 1644 31

(Reduced from the *fac simile* in Mr. Jacob Swart's edition of the Journal of 1642; Amsterdam, 1860.) The original map—which is elaborately coloured—is probably the work of the Pilot-Major Frans Visscher. [See Bibliographical Notes; Manuscript Maps, No. 1, page 44.]

MAP OF ANTHONY VAN DIEMENSLANDT 49

(From Messrs. F. Muller and Co.'s reproduction of the map in Tasman's Journal.) The original map—which is carefully coloured—is contained in the Manuscript Journal preserved in the State Archives at The Hague, and described in the Bibliographical Notes as R.A. 2. [See page 45.]

INTRODUCTION.

The modern era of maritime discovery may be said to begin with the work of Prince Henry of Portugal, surnamed "The Navigator" (1394–1460). Prince Henry devoted his life to the furtherance of geographical discovery. He was inspired by the hope of finding the sea-route to the East, and winning for his country the rich trade of India and Cathay. During forty years he sent out from Lagos fleet after fleet bound for the exploration of the coasts of Africa. Further and further south into the unknown and dreaded Atlantic his caravels pushed their way, until at his death, in 1460, his captains had reached the mouth of the Gambia beyond Cape Verde, and had colonised the Azores. The discoveries made under this Prince's inspiring influence were the stepping-stone to the great voyages which marked the close of the century. Following the initiative of Henry, the bold genius of Columbus conceived the splendid idea of finding the East by sailing west; and, in 1492, when he fell upon America, he believed that he had reached the further shores of India. Five years later Henry's countryman, Vasco da Gama, in a voyage almost as important as that of Columbus, doubled the Cape of Good Hope, and opened the gates of the sea-way to Calicut and the East. Pope Alexander the Sixth by his famous Bull apportioned the world between the discoverers—allotting the western half to Spain, and the eastern to Portugal. From that time the gold and silver of the West were poured into the lap of Spain; while Portugal gathered in as her sole property the rich profits of the coveted trade of the East. For well nigh a century the two nations enjoyed a practical monopoly of the regions which the daring of their sailors had won. Spain, in particular, through the wealth she acquired from her American possessions, became the dominant power in the world, and the mistress of the sea. Her fall from that high eminence was due to her arrogant greed for universal dominion, and her attempt to crush a free nation of traders.

In the 15th and 16th centuries the Netherlands—the Low Countries of common English parlance—were the most prosperous nation in Europe. While other nations exhausted themselves in war, they devoted themselves to the arts of peace. In agriculture they were far in advance of all other countries of the time. The Flemish weavers were the first in the world, and their looms supplied England and all Europe with the best linen and woollen fabrics. In an age when salted provisions were almost the sole winter diet of all classes, the fisheries of the North Sea were nearly as important as the manufactures of Flanders. These fisheries were well nigh monopolised by the Hollanders, and were a rich mine of wealth to the northern towns, while they trained a hardy and daring race of sailors. In addition to their manufactures and their fisheries, the Dutch had become the traders and carriers of the European world. It was Dutch ships and Dutch sailors that distributed throughout Europe the treasures brought by Spanish and Portuguese fleets from the East and West Indies.

The Netherlands were an appanage of the Spanish crown. But the rich manufacturing and trading cities of Flanders and Holland enjoyed considerable liberties and powers of local self-government, granted to them from time to time by their over-lords in exchange for heavy annual payments. It was the attempt of the Spanish king Philip the Second to abolish the charters of their towns, to stamp out their liberties, and to suppress the Reformed Religion by means of the Inquisition, that led to the rise of the Dutch Republic, and the long and cruel war with the revolted Provinces, which lasted eighty years (1566-1648), and finally resulted in the humiliation of Spain.

The Dutch revolt forms one of the most striking epochs in history. It was the first blow struck in modern times for human freedom and liberty of conscience against the despotism of kings and the intolerance of priests. The power of the strongest empire in the world was put forth to crush the revolted citizens. Treachery, torture, and massacre were freely and ruthlessly employed. The butcheries of the Duke of Alva still stand out pre-eminent in the bloody annals of tyranny and persecution. The story, as we read it in the graphic pages of Motley, bristles with deeds of ferocious cruelty and blood.

The struggle would have been hopeless, but that their extremity taught the Dutch to find their strength upon the sea. Powerless before their enemies on land, the patriots took to the ocean. In small vessels their hardy sailors cut off the Spanish supplies, made daring descents on sea-coast towns, and in process of time set themselves to work to strike Spain in her most vulnerable part, her commerce with the New World, from which she drew her wealth. The Beggars of the Sea, as the Dutch rovers styled themselves, became the terror of the richly laden galleons and haughty fleets of Spain. Not only did they cut off the supplies of gold and silver from the New World on which the Spanish King depended, but in the spoils which they wrested from the enemy and in the trade which they were continually extending they found the means for their country to carry on the conflict. England, almost equally in danger from Spanish designs, made common cause against the enemy. Even when the countries were not at open war, Drake and the English seamen acknowledged no peace with Spain beyond the Line, but captured her ships and sacked her settlements on the Spanish Main, returning home laden with treasure. Foiled in his disastrous attempt to conquer England with his Great Armada, Philip was equally unsuccessful in his efforts to destroy the Dutch commerce. In vain did he prohibit the Hollanders from trading with his dominions. In vain did he from time to time lay embargoes on their ships, and send thousands of their sailors to languish in the dungeons of the Inquisition. The bold Hollanders only replied by vigorous reprisals. They mocked at his prohibitions, and continued to carry on an ever increasing and enormously profitable illicit trade. Dutch and English privateers triumphantly swept the seas and harried the Spaniards at their pleasure. Subjugated Flanders had become an obedient Spanish province; her rich merchants had fled, and her people were starving in a desolated country. But the unconquered United Provinces of the north were actually profiting by the war, and every day growing richer and more powerful.

The long struggle on the seas, and its successful issue, roused both in England and Holland an insatiable spirit of adventure. In England this spirit found its outlet in privateering or piratical exploits, such as those of Hawkins and Drake; or in romantic expeditions, such as that of Raleigh to Guiana; and led, in its ultimate development, to the establishment of our Colonial and Indian Empire.

In Holland the adventurous spirit received a strong stimulus from the blind and stupid policy of the Spanish king. For a hundred years—ever since the discovery of the Cape route to the East Indies—Lisbon had been the great centre of the eastern trade. It was thither the Dutch traders came to bring wheat, fish, and other products of Northern Europe, and to carry away in return and distribute the spices and merchandise of the East. In 1594 Philip—who had some time before acquired the crown of Portugal—closed the port of Lisbon, and prohibited Dutch and English ships, even under a neutral flag, from trading with any part of his empire. The blow not only failed of its effect, but recoiled on the striker. It ruined Lisbon; crippled Spain; and made the Dutch East Indian Empire. With a sagacious daring the Hollanders immediately formed the steady resolve to find these eastern treasures for themselves, and wrest the trade from their enemies.

Their first attempt to reach the Indies was discouraging. It was a favourite idea in those days that a short and practicable route to China and India could be found by the north-east passage round the north of Europe. To find this passage and take the Portuguese in the rear was the object of the first Dutch enterprise. The expedition proved disastrous, getting no further than Nova Zembla. Two subsequent expeditions in the same direction met with no better fate.

Baffled in their efforts to find a passage through the frozen seas of the North, the Dutch turned their attention to the old route round the Cape. The merchants of Amsterdam formed a company, under the quaint name of "The Company of Far Lands," and fitted out four vessels, the largest 400 tons, and the smallest only 30 tons burden. The little fleet sailed from the Texel 2nd April, 1595. After a fifteen months' voyage it reached Java, and laid the foundation of the Dutch eastern trade. From this time numerous new companies were formed in Holland: every year fresh fleets left for the east, many of them returning with rich cargoes, and making enormous profits. In spite of the violent attacks of the Spaniards and Portuguese, the Dutch steadily pushed their way in the Eastern Archipelago, and made reprisals on their enemies with telling effect. Their humane and prudent conduct contributed greatly to their success in establishing trade relations with the native princes, by whom the Portuguese were detested for their cruelty, arrogance, and overbearing behaviour.

The English had now entered into competition with the Dutch in the India trade, and in 1600 the first English East India Company was founded. But the English company found their rivals too powerful. In 1602 the various companies in Holland agreed to cease their mutual competition and unite. This was the beginning of the famous Dutch East India Company, which, on 20th March, 1602, received from the States-General a charter for twenty-one years, giving it an exclusive monopoly of the trade with the East. The company had a capital of six and a half millions of florins, or £550,000, more than eight times that of its English rival. It was managed by a body of seventeen directors, known as the Council of Seventeen.

The Dutch had already (1602) established themselves permanently in Java. Here they founded the city of Batavia, which became the centre of their trade and the residence of the Governor-General of their Eastern possessions. They established factories in Malabar, drove the Spaniards from Amboyna and took possession of the island, wrested Malacca from the Portuguese, and expelled the same nation from the Moluccas or Spice Islands. In 1621, less than twenty years after its foundation, the Company had a practical monopoly of the trade in cloves, nutmegs, cinnamon, and other products of the Archipelago. The Portuguese had been driven out, and England only waged an obstinate but unsuccessful rivalry. In 1638 the Dutch supplanted the Portuguese in Japan, and in 1656 got possession of the island of Ceylon.

In a work by Sir Walter Raleigh, entitled "Observations touching Trade and Commerce with the Hollanders and other Nations," presented to King James in the year 1603, we find a striking picture of the commerce of the Netherlands as compared with that of England.

Raleigh attributes the sudden and astonishing rise of the Netherlanders, among other causes, to the "embargoing and confiscating of their ships in Spain, which constrained them, and gave them courage to trade by force into the East and West Indies, and in Africa, where they employ 180 ships and 8700 mariners." (This, it should be noted, was only seven years after the first Dutch vessel had reached Java.) Sir Walter gives a number of interesting particulars respecting the extent of Dutch trade. He says, "We send into the Eastern kingdoms [of Europe] yearly but 100 ships; the Low Countries 3000. They send into France, Portugal, and Italy from the Eastern kingdoms through the Sound and our narrow seas 2000 ships; we, none. They trade with 500 or 600 ships into our country; we, with 40 ships to three of their towns. They have as many ships as eleven kingdoms of Christendom, let England be one. They build yearly 1000 ships, having not one timber tree growing in their own country, nor home-bred commodities to lade 100 ships, yet they have 20,000 ships and vessels, and all employed." In shipbuilding and seamanship also the Dutch sailors in those days were the superiors of the English, for Sir Walter says that while an English ship of a hundred tons required a crew of thirty men, the Hollanders would sail a ship of the same size with ten men.

We are accustomed to dwell on the naval exploits of Drake, Hawkins, and Frobisher, on the enterprise of the Elizabethan sailors and merchant-adventurers, and on the marvellous success of our own great East India Company. We have good reason to feel pride in the deeds of the gallant English seamen of those days, and in the trade which in later times has carried the English flag into every sea. But we are apt to forget how comparatively recent is the predominant position of England in commerce and in naval power. In the 17th century it was the Dutch who were the sailors and the merchants of the world and the masters of the sea. Not London, but Amsterdam, was the great emporium for the products of East and West, the centre of the world's trade, and the richest city on the globe. The commerce of Europe and of the world was in the hands of the merchants of the Low Countries, who had a hundred ships afloat for every one owned by Englishmen.

TASMAN'S LIFE AND VOYAGES.

I.—YOUTH AND EARLY VOYAGES, 1603–1638.

It was in the midst of the Eighty Years War, in the year after the foundation of the Company in whose service he was to win his fame, and in the same year that Sir Walter Raleigh presented to King James his memorial on the trade of the Hollanders, that Abel Janszoon Tasman stepped onto this world's stage. He was born in the little inland village of Luytjegast, in the province of Groningen, in the year 1603. Groningen is the most north-easterly province of Holland, and formed part of the ancient Friesland. It is flat, even for proverbially flat Holland. The highest hill, the Doeseberg, rises to a height of only 35 feet above the level of the ocean, and some of the country lies even below the sea level. It is protected from the furious inroads of the North Sea by magnificent dykes of timber and stone. Behind these massive ramparts stretch wide and fertile fields and meadows, rich in agricultural and dairy produce. The cultivators, who hold their lands under a species of tenant right, are at present the richest and most prosperous peasant farmers in the whole of Europe. In Roman times the Frisians occupied the country from the Elbe to the Rhine, including the extensive tract now covered by the Zuyder Zee, over which the sea burst so late as the thirteenth century. They were sea rovers as well as cattle herdsmen, and were distinguished for their fierce independence and indomitable love of liberty. They were one of the tribes that took part in the conquest of Britain. At this day the Frisian language, spoken by a handful of people, is the most nearly related of all Low German dialects to the English, and the men are nearest to the English in blood. The Frieslanders are of a different race from the inhabitants of Holland proper. The typical Dutchman is squat and short-legged; the Frieslander, tall, yellow-haired, blue-eyed, and of powerful build. We may fairly believe that Tasman belonged to this tall, bold, and impetuous race, who supplied no small proportion of the hardy fishermen and sailors whose daring made Holland a great sea power.

We have no information as to the Tasman family, but it is to be presumed that its social status was a humble one. How Abel came by the surname which is now world-renowned is a matter of dispute. In the Luytjegast district family names were unknown until the beginning of this century. The son added to his own christian name the christian name of his father; thus, Abel, the son of John, became Abel Janszoon, and by this name simply Tasman is often designated in the old records. A nickname was often acquired, derived from some personal peculiarity, from a trade, a sign, or a ship. It has been conjectured that either Abel Jansz or his father took the name Tasman or Taschman from a boat or vessel named the *Tasch* (bag or net), belonging to the family.*

Of young Abel's early life in the flat polders or meadows of Luytjegast there is no record. The boy would see little or nothing of the horrors of the war which for forty years had been desolating a great part of the Low Countries. The most desperate part of the struggle was over with the death of Alexander of Parma. The gloomy bigot and tyrant, Philip the Second, was dead. Flanders had fallen, and had become an obedient and desolate Spanish province, under the rule of the Archduke Albert and his wife Isabella of Spain; but the United Provinces, under Prince Maurice of Nassau, son of William the Silent, were not only holding their own against the Spaniards, but were daily growing in prosperity and power. When young Abel was six years old they had succeeded in wringing from their exhausted enemy a twelve years' truce, with the acknowledgment of the Republic, and of its right to carry on the India trade. The boy's imagination must have been often stirred by tales of the daring deeds of the Beggars of the Sea, and the heroic resistance of Hollanders and Zeelanders to the mighty power of Spain. Not less must his spirit of adventure have been stimulated by the stories that drifted to his quiet village telling of the riches of India, of the Spice Islands, and of far Cathay. Small wonder that the old sea-roving Frisian blood asserted itself, and that Abel Jansz, like the majority of Hollanders in that age, found his vocation as a sailor. That he had managed to acquire some education is evident from the fact that he had at least learned to write, a somewhat rare accomplishment in those days for persons in his humble station.

It is not unlikely that in the fisheries of the North Sea, that nursery of daring sailors, he served his first apprenticeship to the ocean. But the adventurous spirit was strong within him, and it was natural that he should soon find his way to

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* In the Archives of Hoorn there is a document relating to a ship called the *Tasch*, of which the skipper was Cornelis Gerritszoon Taschman.

Amsterdam, the centre of the commerce of the world, eager to seek his fortune in the rich eastern lands which his countrymen had won. He had married young—either in his native province or in Amsterdam—and his wife, Claesjie Heyndricks, had died, leaving him an only daughter. When we get the first definite information respecting him he was a widower, living in the Terketelsteeg (Tarkettle Lane), one of the poorest quarters of Amsterdam. Here, on the 27th December, 1631, he married his second wife, Jannetjie Tjaers.* He was not encumbered with property,—at least his name does not appear in the contemporary register of assessment for the half per cent. tax. His wife was not greatly his superior in social position, and could not sign the marriage register. She belonged to a working-class family,—her father being a powder-maker, and her brother a sailor, like her husband. The family were not, however, altogether without means. They were owners of one, if not two, small houses in Amsterdam. The young couple began life in a more respectable locality than Tarkettle Lane, setting up house in the Palm-street. It cannot have been long after his marriage that Abel Jansz, then 28 or 29 years old, made what was probably his first voyage to the East Indies, in the service of the Dutch East India Company. That shortly after this time he was in the service of the Company in the Eastern Seas we know from independent evidence. Mr. Heeres has found in the old Colonial archives two declarations signed by Tasman in 1634, which inform us of his rapid rise, during the space of two years at most, from the position of a simple sailor to that of master of a ship. In May he was mate of the ship *Weesp (Wasp)*, trading from Batavia in Java, to Amboyna in the Moluccas. In July the Governor of Amboyna appointed him master—"skipper" was the term in those days—of the jacht† *Mocha*.

Tasman was therefore employed in the spice trade, the chief centre of which was the Moluccas or Spice Islands, and especially Amboyna and the Banda Isles, the native home of the nutmeg and the clove. In these days it is difficult for us to understand the value which our forefathers, even down to the end of the 17th century, set upon eastern spices—pepper, cinnamon, ginger, nutmeg, and especially cloves. It has been remarked that at banquets in England in the Middle Ages a place next to the spice-box was more coveted than the proverbial place above the salt. This may probably be explained by the fact of the little variety of food possible during the Middle Ages, when (in the winter especially) all classes had to live mostly on salt provisions—especially salt fish—and had hardly any fresh vegetables, until the Dutch taught Europe how to grow them. Before the discovery of the route round the Cape, a pound of spice was often worth as much as a quarter of wheat. After Da Gama's voyage the trade remained for a century in the hands of the Portuguese, and the monopoly yielded them enormous profit, sometimes as much as fifty-fold. The hope of getting possession of this coveted trade was the chief incentive to Dutch efforts to reach the Indies. Pepper, ginger, and cinnamon were too widely grown to enable them to command a monopoly, and in these articles the English East India Company was able with more or less success to divide the trade with the Dutch. It was otherwise with the more valued spices, such as nutmeg and cloves. These were limited to a few of the East India Islands. Cloves in particular grew nowhere but on two or three islands of the Moluccas. To secure the monopoly of these the Dutch accordingly bent all their energies. In 1605 they succeeded in driving the Portuguese out of Amboyna, and obtaining the mastery of the whole of the Moluccas. The English East India Company kept up an obstinate rivalry, but the Dutch met them with determined hostility. They attacked the English factories on small pretext, captured their vessels, and, after the massacre of a number of English traders at Amboyna, in 1623, finally excluded their rivals from all share in the trade. This contest for the spice trade was the origin and chief cause of the long and bitter enmity between the two nations. To such lengths did the Dutch go that some years later they ruthlessly rooted up the clove plantations on all the islands of the Moluccas except Amboyna and Banda. Here alone did they allow the clove to be produced, in order that they might enhance the price and make certain of preserving their monopoly.

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* The following is a translation of the entry in the Register of the Amsterdam Church, dated 27 December, 1631:—Abel Janss. of Luttiejast, seaman, aged 28 years, living in the Terketelsteech, widower of Claesjie Heyndricks; and Jannetie Tjaers, of Amsterdam, aged 21 years; her sister Geertie Tjaers being present, living in the Palm-street. [In the margin.] Dirckie Jacobs, the mother, consents to the said marriage, as Jan Jacobs attests.

† "Jacht," a small ship of from 100 to 200 tons burden.

But to return to Tasman. It is evident that his singular capacity had soon made itself evident to the colonial authorities, for in August, 1635, we find the simple sailor of three years before, now as "Commandeur Abel," cruising at the head of a fleet of small vessels (*kiels*) to protect the jealously guarded monopoly from foreign intrusion, and generally to harass the ships of hostile European rivals in the waters of Amboyna and the Banda Sea. In September, 1636, he was on his way back to Batavia, the centre of Dutch rule and the residence of the Governor-General of the Indies. On his arrival, he found himself involved in difficulties with his crew. They cited him before the Chief Magistrate's Court complaining that while cruising in the Banda Sea he had, presumably in the interests of his own pocket, stinted them of their necessary allowance of rations. As he was acquitted by the Court, which was sufficiently experienced in such matters, we may conclude that he was unjustly accused : at least we may give him the benefit of the doubt.

He was now bent on revisiting the home country, and to accomplish this he was ready to accept for the time a subordinate post, and accordingly shipped as mate on board the *Banda*. The *Banda* was the flagship of a homeward-bound fleet (*retour vloot*) of several sail. Her skipper was Matthys Quast, a bold and capable sailor, of whom we shall hear more presently. When on the point of sailing, on 30th December, 1636, the officers and crew, 111 in number, were required to make a declaration, which is interesting as illustrative of the troubled state of the times, of the dangers of war, and the prevalence of privateering. It also shows the survival of the ancient usage—a part of the old maritime law of the 13th century, the Roles d'Oléron—which gave to the ship's Council, and even to the common sailors, a voice in the control of the voyage. By this declaration—to which the whole 111 set their signatures or marks—the Governor, skipper, merchant, mates, officers, soldiers, and seamen, presently appointed and sailing on the ship *Banda*, solemnly promised that, in view of the Spanish men-of-war and the privateers of Dunkirk, they would in no wise pass through the English Channel, but would hold their course round England, Ireland, and Scotland, so that they might in safety make the harbours of the Fatherland.

The *Banda* arrived at the Texel on 1st August, 1637, after a seven months' voyage. Tasman remained at Amsterdam for some months with his wife Jannetie, who had recovered from an illness so serious that she had made her will. This will is still in existence. It was drawn up on 18th December, 1636, by the Notary, Pieter Barcman. It recites that the worthy Jannetje Tjercks, wife of Abel Jansz Tasman, citizen, was then lying ill in bed, but was of good memory and understanding. Her residence was at the corner of the Palm cross-street on the Braeck. Should the testatrix die without issue, then, after certain bequests to the poor, she constituted her sister, Geertje Tjercks, her sole legatee. There is no mention of her husband or of the little step-daughter, Claesjen. We need not therefore assume that there had been any quarrel between the married pair. The absence of Abel in the

Indies, from which return was so uncertain, may explain why the wife should leave her property to relations on the spot.

Meantime Abel and his brothers-in-law appeared before the Amsterdam magistrates with the object of selling the family house in the Palm-street for 500 florins. For some reason the contract was cancelled, and the family retained the house until 1650, when Powels Barentsz, in his own name, and as attorney for his brother-in-law Tasman, who was then in the Indies, conveyed the property to Andries Barents.

After a stay of some nine months in Amsterdam, Abel Jansz once more set his face eastwards. He entered into a new ten years' engagement with the Company, and in consideration of this he was allowed to take his wife with him—the Council of Seventeen having just passed a new regulation whereby the chief officers were permitted to take their wives to the East Indies, provided they were lawfully wedded, were of good lives, and could show good credentials. Tasman was put in command of the fly-ship* *Engel* (*Angel*), fitted out by the Amsterdam Chamber. The *Engel* sailed from the Texel, 15th April, 1638, and arrived at Batavia on 11th October following. The skipper's pay was 60 guilders (£5) per month. On arrival at Batavia he was continued in his post for three years at an increased pay of 80 guilders (£6 13*s*. 4*d*.) per month.

II.—VOYAGES IN JAPAN SEAS, &c., 1639-1642.

It is in the year following his return to Batavia, some six years after his first voyage thither, that we find Abel Jansz first chosen to take a prominent part in a discovery expedition.

The enterprise of the early Dutch governors in their efforts to open up new trade for their Company was ceaseless. Jan Pieterszoon Coen, Governor-General between 1618 and 1629, was the most illustrious, and the one who did most to consolidate the Dutch power. He it was who built the fort at Batavia, and fixed the centre of government there. He it was who in Java baffled the English, and overmastered them in the Moluccas. During his rule Dutch ships first made the coast of Australia. After Coen, the most famous governor—he who showed the greatest energy in his persistent search for new lands and new markets—was Antony van Diemen, the Governor-General who was in power when Tasman returned to the Indies, and with whom his fame will be for ever associated.

Early in the career of the Dutch Company in the Eastern Archipelago the Directors had cast longing eyes towards the powerful kingdom of the Great Khan—the Cathay whose wonders had been first revealed to Europe by the traveller Marco Polo in the 13th century. Not many years after Da Gama's discovery of the Cape route (1516), the Portuguese had penetrated to Canton, and by the middle of the 16th century (1542) had established relations with Japan, where, for a time, they exerted a great influence, and carried on a lucrative trade. When the Dutch reached the East they were not slow to follow in the footsteps of their rivals. Seven years after the foundation of the Company they sent ships to Japan, and continued to trade there every year, in spite of the violent opposition of the Portuguese. Finally they were allowed to set up a factory on Firando, an island to the west of Kiusiu, and this soon became one of the most profitable stations of the Company's trade.

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* Fly-ships (*fluit*) were long quick-sailing ships, of light draught, varying from 200 to 400 tons burden. Fly-ships were first built at Hoorn in 1594.

In 1635 a certain William Verstegen, residing at Firando, sent a letter to Batavia stating that the Japanese reported that many miles to the eastward, in latitude 37½° North, there was "a very great country or island, rich without measure in gold and silver, and inhabited by civilised and friendly people." This was just the sort of report to excite the imaginations of those early traders, who were constantly tantalised by dreams of a new Mexico or Peru to be discovered in the Pacific. It was known that in 1620 the Spaniards had searched in vain for this golden island ; but, undeterred by the former failure, Governor-General Van Diemen and his Council resolved to fit out an expedition to make the discovery. The scheme, through various domestic troubles, lay in abeyance for some years, but in 1639 two ships were fitted out for the adventure. Tasman's ship, the *Engel*, was one of the vessels chosen. The other was named the *Gracht* (*Canal*), and was under the command of an experienced sailor and pilot, Matthys Hendrikszoon Quast, under whom Abel had sailed as mate in the *Banda* on the homeward voyage three years before. Quast was chief, and Tasman second in command. Tasman was now about 35 years old; he had been but six years in the Company's service, and had not only risen from the grade of a simple sailor to that of captain of a ship, but was now entrusted with the second place in a difficult and important enterprise. His rapid promotion proves that Quast and the Colonial authorities had recognised in him high qualities as a seaman and a leader of men. The ships sailed from Batavia on 2nd June and made their way round the north of the Philippine Islands, keeping a north-easterly course until on 20th July they sighted some islands belonging to a group now known as the Bonin Archipelago. Thence they steered north-east, and then back to the Japan coast searching for the land of gold. From this point they pushed out again into the great ocean further than any one before them, to a distance of some 2000 miles east from Japan. For two months longer they cruised backwards and forwards in those far northern seas, between 37½° and 46° north latitude, straining their eyes in vain for some indication of the golden island. They were in a wretched condition. Many of the crew had died, and the number of sick increased daily. The remnant were worn out with the hardships of the voyage, and barely able to do the incessant pumping necessary to keep their leaky vessels afloat. Their provisions were running short, and there was still no faintest sign of land. Disappointed and dejected, the commanders and ships' council reluctantly resolved to give up a fruitless search. On the 25th October they turned their ships for Formosa to obtain refreshment for the sick, and to refit. Taking the coast of Japan on their way, they came to an anchor on the 24th November, before Fort Zealandia, on the island of Tayouwan or Formosa, then a Dutch possession. They had been nearly six months at sea, and out of a crew of ninety had lost nearly forty men. No further search was ever made for the wonderful island.

In the following year Tasman made another voyage to Japan, this time for the purposes of trade, as skipper of the fly-ship *Oosthappel* (*Eastchapel*). The fleet with which he sailed consisted of eleven ships, carrying freight valued at £525,000; The *Oostkappel's* cargo alone was worth £80,000. This gives us an idea of the value of the Japan trade. The Hollanders were now the only Europeans allowed to trade with the country. The Portuguese had for nearly a century carried on a most profitable trade, but their arrogance and intrigues, and above all the proselytising zeal of the Jesuit missionaries—who had made many thousand converts, and acquired an enormous influence—excited the jealousy and hostility of the Government. Christianity was suppressed. Foreigners were excluded from the Empire, and only allowed to trade with Firando and Nagasaki. In 1639 an insurrection led to a general massacre of the Christians, and the absolute expulsion of the Portuguese under pain of death.

The *Oostkappel* arrived at Firando on 25th August, 1640, and lay there for some three months. During her stay the Dutch got into serious trouble with the Japanese Government and were compelled to demolish their factory, which was too much like a fort to satisfy the susceptibilities of the Imperial Government. Mr. Lauts has given us the resolutions of the Council of the Dutch Factory at Firando in 1640. When the Imperial rescript arrived, Tasman, in virtue of his commission as captain of the *Oostkappel*, sat as a member of the Council, and signed its resolutions. The situation was most perilous, but Francis Caron, the president of the Council, returned the prudent answer: "All that His Imperial Majesty is pleased to command, we will punctually obey." Still the Dutch were slow in proceeding with the work of demolition, and it was not until another Imperial rescript arrived, threatening to put the members of the Council to death if the order was not instantly obeyed, that the great stone factory—which had cost the Dutch 100,000 guilders to build—was finally levelled to the ground. They were compelled to submit to the most vexatious restrictions, and to put up with countless humiliations in order to maintain their position. But the trade was too valuable to be lightly relinquished, and by their submission the Dutch alone of European nations for more than 200 years managed to retain trade relations with Japan, though living as the Japanese said "like frogs in a well," until in 1853 the American squadron under Commodore Perry broke in upon Japanese isolation and paved the way for that remarkable revolution, the latest development of which we have seen in the recent war between Japan and China.

In May, 1641, Tasman sailed from Batavia to take in a cargo at Lauwek, the capital of Cambodia, and then to proceed to Japan. The Cambodian Kingdom at that time extended over a great portion of south-eastern Further India, now Cochin China. Its capital, Lauwek, on the great river Cambodia, was one of the most important cities of the east; it was the centre of a great trade in furs, ivory, silk stuffs, and other merchandise, which were brought from the interior and from China and exported to Japan and other places. The Dutch, as the price of assistance given to the King in some of his wars, had a few years previously obtained leave to set up a factory at Lauwek, which was of great value to them in the Japan trade. For this factory Tasman sailed in his ship the *Oostkappel*, and in July came to an anchor in the Lauwek Roads. On his arrival he found the Dutch and Portuguese in violent conflict. A few days before a dispute had arisen between the crew of the Dutch fly-ship *Zaijer* and the Portuguese, and this, through the overbearing arrogance of the latter, had grown into a fight, and had cost some of the Dutch their lives. The Directors of the factory had appealed to the King to punish the offenders, but the Portuguese having won him over by bribes were only sentenced to pay a fine. This blood-money the Dutch refused with contempt, and since neither by entreaty nor in any other way could they obtain a juster sentence, they resolved to exact satisfaction themselves. At this critical juncture Tasman made his appearance at Lauwek, and as he lacked neither the courage nor the inclination to avenge the murder of his countrymen, he soon found an opportunity of inflicting an exemplary punishment on the enemy.*

Since their expulsion from Japan the Portuguese had contrived to keep a share of the trade by importing their wares under the Cambodian flag. On the *Oosthappel's* arrival, a rich cargo of silks from Macao (the Portuguese settlement at the mouth of the Canton River) was being transhipped into two junks flying the Cambodian flag in order to be sent to Japan. Tasman had express instructions to attack and make prizes of all Spanish, Portuguese, and other foreign ships not provided with free passes from the Dutch Company giving them permission to trade. He therefore rapidly discharged his cargo, loaded for Formosa, and then weighed anchor and cruised outside the river to look out for the Portuguese junks. A few days after leaving the river the junks hove in sight, and Tasman gave chase. He soon overhauled one of them, and after a sharp fight the junk surrendered, and her silks, worth 5500 dollars, were transferred to the *Oosthappel.* The other junk (with a cargo worth 5000 dollars), aided by the gathering darkness, succeeded in escaping, and Tasman, abandoning further pursuit, proceeded with his spoil to Formosa. His conduct in this matter did not, however, meet with the approval of the authorities at Batavia, and Abel, for his alleged negligence in not capturing the second junk, was condemned to forfeit two months' wages. On leaving Formosa, the *Oosthappel* was overtaken by a violent storm. She lost her mainmast, and was so disabled that the ship's council judged it impossible to proceed with the voyage to Japan. The ship therefore made for Formosa, and after a most perilous voyage contrived to reach Fort Zealandia. Here the cargo for Japan was transhipped to the *Zaijer*, and the *Oosthappel* was sufficiently repaired to be able to sail under jury rig with a cargo of silks for Batavia, where she arrived on 20th December.

Although Tasman, as we have said, was fined two months' wages for dereliction of duty in allowing the Portuguese junk to escape him, it would appear that this was but a necessary part of the rigid discipline of the Company, and involved no real disgrace. His voyage with Quast in search of the "golden island" had tested his qualities of hardihood and endurance; his voyages to Japan had proved his skill and resource in seamanship; his services in the Banda Sea, and his smart action at Lauwek (in spite of nominal blame) had shown his courage and capacity, and his zeal and determination as a stout upholder of the rights and privileges—not to say of the arrogant assumptions—of the Company. Van Diemen, ever on the watch for capable and resolute men who could further his plans for the extension of Dutch supremacy in the East, had recognised Abel's great qualities. This is plain from the important enterprises with which he was constantly entrusted. So little did his failure to capture the junk affect his standing, that within three or four months after the infliction of the fine the Governor-General offered him the conduct of an important mission, in which not only his resolution but his diplomatic skill would be put to proof. Amongst other countries in which the Dutch had early established themselves was the great island of Sumatra. They had soon elbowed out the Portuguese, and now had factories at Acheen, Djambi, and other places. The most important of these was at Palembang (not far from the coasts of Java.) This post commanded the pepper trade of the south of the island. The powerful Sultan of Palembang had long been on most friendly terms with the Dutch, but through the machinations of a Chinese named Bencki, who had fled from Batavia in debt to the Company, and had managed to ingratiate himself with the Sultan, these relations were seriously imperilled. The differences and misunderstandings which had arisen now threatened to end in war. It was with the view of bringing the Sultan to a better mind that Tasman was despatched to Palembang with a fleet of four vessels. He left Batavia on 23rd April, 1642, and two or three days later the little squadron cast anchor in the mouth of the river on which the Sultan's capital was situated. Here, by way of preliminary, Abel Jansz took possession of some junks loaded with pepper, and having transferred their cargoes to his own vessels, he sailed up the river to Palembang. His instructions were to do his best to arrange matters by friendly means before having recourse to hostile measures. He therefore sought an interview with the Sultan. To the surprise of the Dutch, the audience was not only granted, but the ambassador met with a most friendly reception. Abel showed himself a skilful diplomatist. He disabused the Sultan's mind of the prejudices instilled by the Chinaman, and dwelt on the good disposition of the government at Batavia. He showed the importance, not only to the Company but also to the kingdom of Palembang, of the maintenance of the trade and of the amicable relations hitherto existing. Finally he urged, in forcible terms, the mischief that would ensue from a war between the two hitherto friendly powers. It is perhaps doubtful whether the diplomatist's words would have been as convincing if they had not been supported by the tangible argument of a squadron of ships, commanded by a man who clearly was not to be trifled with. But, however that may be, the Sultan was completely won over, and without further hesitation renewed the treaty of friendship. Tasman's mission being thus successfully completed, he returned with his fleet to Batavia, carrying with him the obnoxious Chinaman, and was received by Van Diemen and his Council with the warmest acknowledgments for his services in having extricated them from what had at one time threatened to be a very serious trouble.

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* Voormeulen van Boekeren, p. 33.

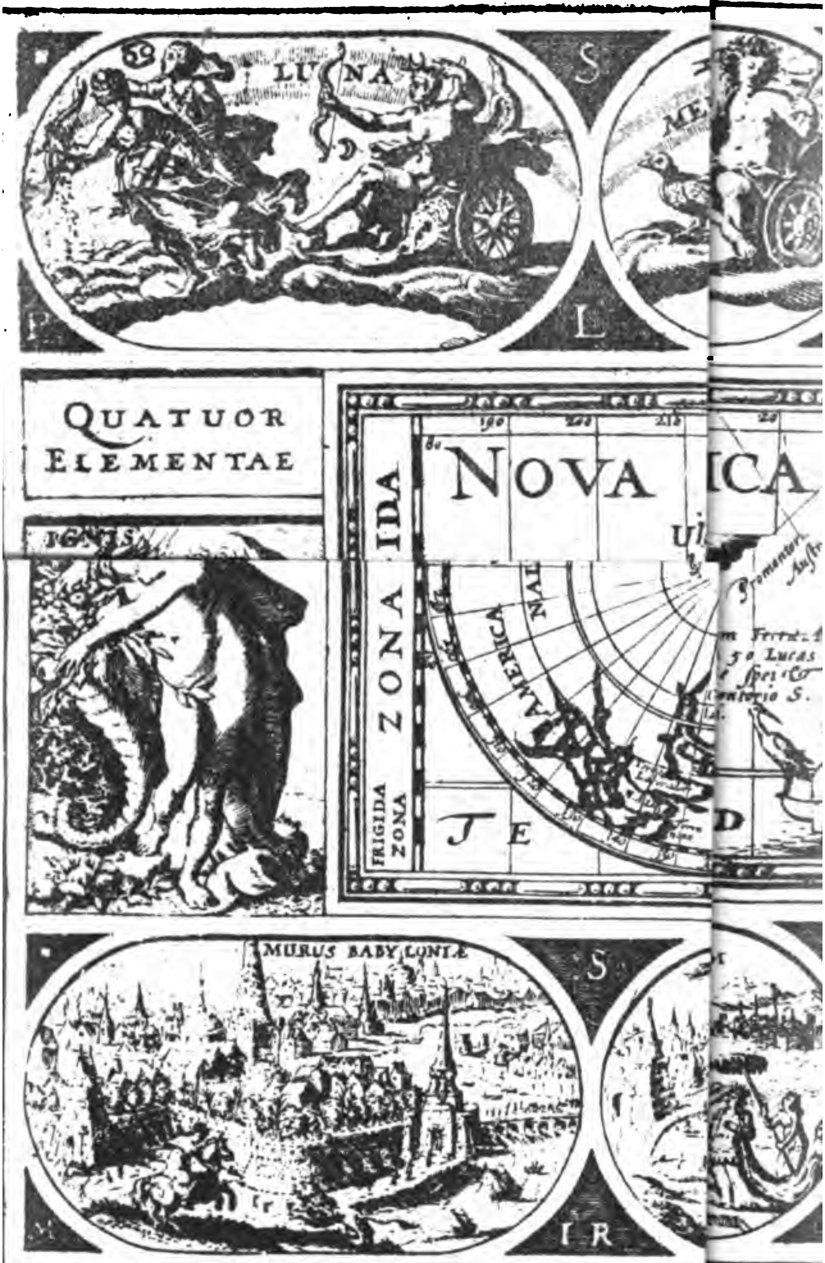
III.—THE GREAT DISCOVERY VOYAGES TO THE SOUTHLAND, 1642-1644.

1.—*The Unknown Southland.*

Tasman was now in his fortieth year. In ten years' wanderings and fightings in the service of the Company he had grown enured to hardships and danger. He was familiar with the great trade routes from Europe to India, with the intricacies of the waters of the Eastern Archipelago, and with the navigation of the Seas of China and Japan. He had sailed a thousand miles beyond the limits reached by any previous navigator into the unknown and mysterious regions of the cold and stormy North Pacific Ocean. In his many voyages he had proved himself a keen trader, a capable and daring seaman, a bold fighter, and an able commander. He was now ready to undertake the great adventure, the crowning achievement of his adventurous life—that voyage to the Great Southland, which, as a Dutch historian says, "must specially immortalise him; the expedition which must ever give him an honorable place amongst the greatest navigators and discoverers."

The Great Unknown Southern Continent—Terra Australis Incognita, or Nondum Cognita—had for ages been the dream of geographers. The ancient cosmographers had formulated a theory as to the existence of a huge continent in the south, which they considered necessary to balance the large continents in the northern hemisphere. The discovery of North and South America only lent fresh weight to this conjecture, and it was commonly supposed in the 16th and 17th centuries—and indeed was almost an article of faith—that below the Equator there was a huge continent which had still to be discovered and explored.

It was in 1513 that the Spaniard Vasco Nunez de Balboa first saw the Pacific from a mountain in Panama. Ferdinand Magellan was the first to enter it. Leaving Spain in 1519, with five small ships of from 130 to 60 tons, this heroic navigator felt his way through the Strait which bears his name, and crossing the great ocean, after months of suffering reached the Ladrones. He himself was killed at the Philippines, but one of his ships, the *Victoria*, with a handful of men, returned to Spain, after a voyage lasting three years, having been the first to circumnavigate the globe. Magellan's voyage was prompted by the desire of Spain to find a way to the Moluccas on the west, with the object of disputing the claims of Portugal, and wresting from her the spice trade. With a similar object, the Spanish Viceroys of Mexico and Peru despatched various expeditions to the Moluccas. In one of these voyages, in 1528, Saavedra, sent out by Cortez, sighted New Guinea, which had previously been seen by the Portuguese. In 1564 the Philippines were colonised by the Spaniards. In another voyage, in 1568, Mendana discovered the Solomons, and brought to Peru such a glowing account of their wealth that in 1595 he was despatched with a fleet to found a settlement there. He failed, however, to find the islands, and unsuccessfully attempted to plant a colony on Santa Cruz. Fernandez de Quiros, his pilot on this voyage, was firmly persuaded that here at last was the great Terra Australis. He petitioned the King of Spain to be allowed to colonize it, and in his memorial "it is soberly affirmed to be a terrestrial paradise for wealth and pleasures." He declares that the country abounds in fruits and animals, in silver and pearls, probably also in gold, and is nothing inferior to Guinea in the land of Negroes. In 1605 Quiros set out from Peru with a powerful fleet to settle a plantation in the southern paradise. On a large island which he discovered, and which he took to be a part of the Southern Continent, and named Australia del Espiritu Santo—it is in fact one of the New Hebrides—he founded the short-lived and unfortunate town of New Jerusalem. One of his companions, Luis Paz de Torres, separated from the fleet and steered westward, sailing through the strait which now bears his name, and skirting the south coast of New Guinea. The first Englishman to enter the Pacific was Sir Francis Drake. In his "Famous Voyage" in 1577 he stole through Magellan Strait, fell upon and plundered the Spanish settlements in Peru, and, following in Magellan's track across the South Sea, made the Moluccas, and returned to England laden with booty. In the latter part of the 16th and early part of the 17th centuries several Dutch navigators accomplished similar circumnavigations. All these expeditions crossed the Pacific near the equator, and though they discovered islands they threw no light on the problem of the Terra Australis. More important was the voyage of the Dutch navigators Le Maire and Schouten in 1616. They found a new passage into the South Sea, between Tierra del Fuego and Statenland. Sailing through this Strait of Le Maire they reached the open ocean,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doubled Cape Horn, and crossed the Pacific in a higher latitude than Magellan and Drake. Being so far to the south as 17° S. lat. they confidently expected to fall in with the great Southland, but were constantly disappointed, finding nothing but a few islands. Le Maire's ships, on reaching Batavia after their long voyage, were seized and confiscated by his countryman, Governor-General Coen, for having come into the Indies in violation of the charter of monopoly of the Dutch East India Company. This damped the ardour of explorers for many years, so much so that for nearly a century no Dutch navigator ventured again to attempt the circumnavigation of the globe.

These various expeditions had somewhat circumscribed the possible area within which the Southland might be found. Still the old cartographers found the idea of a sea full of islands so little in harmony with their prepossessions, that in the early part of the 17th century (even so late as 1640) they boldly drew on their maps of the world a huge "Terra Australis Nondum Cognita." This was depicted as surrounding the South Pole, and occupying a very considerable portion of the Southern Hemisphere. In the South Atlantic the Promontorium Terræ Australis jutted northwards towards Africa. On the west only the narrow Straits of Magellan and Le Maire broke its continuity with South America and gave the sole means of passage into the South Sea. On the eastern side this continent of the mapmakers blocked all access to the Pacific. It extended in a solid but gradually narrowing mass from the Pole up to the very Equator. In this respect the maps were a jumble compounded of discoveries, actually made but imperfectly known, fitted on to a baseless theory. It is pretty certain that Portuguese ships sailing from the Eastern Archipelago had somewhere between 1512 and 1542 seen the north-west coast of Australia, and that these discoveries were vaguely indicated on some of the early charts. They appeared on the cartographers' maps as the land of Beach, exceedingly rich in gold. New Guinea had been sighted by the Portuguese Maneses in 1511, and again by the Spaniard Saavedra in 1528: therefore Nova Guinea appeared as the most northerly extension of the continent under the Equator—sometimes as an island separated by a narrow strait, sometimes as an integral part of the continent itself. Beyond New Guinea it is probable that the reported discovery by the Portuguese of certain vague and imperfectly known lands forming part of the coast of Australia justified the delineation of the north-eastern shores of the continent. But from the point where information failed imagination stepped in, boldly carrying the coast-line from Queensland down in a south-easterly direction to Magellan's Strait and Cape Horn, and filling the South Pacific with an imaginary continent.*

When the Dutch had established themselves in the Eastern Archipelago, their spirit of enterprise and adventure, and their ambition to win new realms for the Company's trade, were only stimulated by their unprecedented success. It became an object of ardent desire to the Home Directors, the Council of Seventeen, and to the successive Governors-General of the Indies to explore the mystery of the Great South Land; if, perchance, they might there find a second Mexico or Peru, rich in gold and silver, or new spice islands, to increase the profits of their trade; or, at the least, to discover a direct way from their eastern possessions, by the Great South Sea, to Peru and Chili, which would make it easy for them to harass and plunder the Spanish ships and the settlements of South America. It was in 1605—only three years after the foundation of the Company—that the first attempt was made; and the object of this expedition was limited to the exploration of the regions lying to the east of the Banda Islands. With this view, the *Duyfke* (*Little Dove* or *Darling*) sailed from Batavia in 1605, visited the Island of Aru, sailed along the south coast of New Guinea, and reached Cape Keer Weer, in 13° S. lat., on the east side of the Gulf of Carpentaria—her captain thinking, however, that he was still on the west coast of New Guinea.

For a number of years the want of suitable vessels which could be spared from the needs of the East India settlements, and the hostilities in which they were constantly involved with their European rivals in the spice trade, coupled with the necessity of consolidating their power in the Eastern Archipelago, prevented the Colonial authorities from engaging in distant adventures. The first Dutch discoveries on the west coast of Australia were not the result of design, but were accidental—or, at least, unpremeditated.

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* The prepossession in favour of a Southern Continent was inveterate in the 17th and 18th centuries. When Tasman made the west coast of New Zealand he was confident that at last he had discovered the west side of the long-sought Terra Australis Incognita So late as 1771, Alexander Dalrymple—the Hydrographer to the Admiralty, and the jealous rival of Cook—published a collection of voyages to the South Sea with the express object of demonstrating the existence of a huge Southern Continent. The only part of the Pacific then unexplored was that lying between New Zealand and Magellan Strait. This gave nearly the area which, by elaborate calculation, Dalrymple showed was necessary to preserve the equilibrium of land between the northern and southern hemispheres. He therefore concluded that this space south of the Equator must be almost entirely solid land. Within four years of the publication of Dalrymple's work, Cook in his second voyage, by sailing over the site of the imaginary continent, finally dissipated the fable, and reduced the Terra Australis Incognita to the frozen mass within the Antarctic circle.

When the Hollanders first made their way to the East Indies they naturally followed the old routes taken by their Portuguese predecessors and rivals. After rounding the Cape of Good Hope they shaped their course either inside or outside Madagascar, and thence made their way as best they could—either north to India or east to Java. This route had many disadvantages. Numerous rocks and islands, the positions of which were imperfectly known, lay in the track, and were a constant source of danger. The south-east trade winds drove the ships to the northward, and, as they got into the tropics, they met with light, variable, and baffling winds, which delayed them for long weeks, so that it was no uncommon thing for the outward voyage to last thirteen months. Nor was the loss of time, and consequent damage to cargo, the only evil. Scurvy—the scourge of all early voyagers—produced by the long and exclusive use of salt diet, attacked the crews. Many died, and the survivors arrived at their destination broken down by sickness, and often short of provisions and water.

Bad as the Madagascar route was, the Dutch, for more than fifteen years, were unable to find a better. At last, however, in December, 1611, Commander Hendrik Brouwer, who had sailed with two ships from Holland to the east, wrote to the Council of Seventeen, reporting his arrival at Java. After leaving the Cape he had run due east in about 36° S. lat. for some 3000 miles. He had kept a strong westerly wind for 28 days, and had reached Batavia after a passage of less than seven months, having lost only two men from sickness. This was unprecedented; and he strongly advised that all outward-bound ships should be ordered to take the south route, by which they might make sure of short passages—seeing that if they failed to get west winds in 36° S. they would be certain to do so if they ran to 40° or 44° S. Although the long distance run to the south seemed a disadvantage, it was largely compensated for by the gain of running down the easting in a high latitude. It was open sea all the way in this southern ocean, with none of the rocks and dangers which beset the northern route, and the coolness of the weather was of great importance to the health of the crews.

In consequence of Brouwer's report, seconded by the recommendation of Governor-General Coen, the Directors ordered their outward-bound ships to take the new route. Rewards were offered for quick passages—150 guilders for a passage under nine months, 600 guilders if they arrived within seven months. The superiority of the new route was soon apparent. Of three ships sailing at the same time from Holland in 1614, the *Hardt* took Brouwer's route and reached Batavia in six months, while the two others by the Madagascar passage were 16 and 18 months in making the voyage. It was in running far east under the new sailing directions that in 1616 the ship *Eendragt* (*Concord*) first sighted the South Land (*i.e.* the west coast of Australia), in 26° S. lat., at Shark Bay; her captain, Dirk Hartog, landing on an island which still bears his name, and putting up an inscribed metal plate, which remained there up to the early part of the present century. The voyage was not without danger, as an English ship, the *Tryal*, found to her cost; for, following the new Dutch route in 1621, she ran onto the Trial Rocks in 20° S. lat., and was totally wrecked, only a few of her crew succeeding in reaching Batavia in the boats.

From Hartog's ship the new discovery received the name of Eendragt Land, and in the next four or five years the captains of other ships on the same voyage sighted the west coast, amongst them Edel and Houtman, who in 1619 made the South Land in 32½° S. lat.—north of the present site of Perth—and sailed along it some hundreds of miles, giving it the name of Edel Land, and also naming Houtman's Abrolhos.

Instructions were issued by the Directors in 1620 and 1621 that outward-bound ships leaving the Cape should keep an east course between 30° and 40° S. lat. for 4000 miles, or until they should sight the "New Southland of the Eendragt." With our modern notions these instructions appear extraordinary, but in the then existing state of navigation they were practical and well judged. The appliances at the command of ship captains in those days were very imperfect. Without the sextant or the chronometer there was the greatest difficulty in determining the ship's position. It is true that they could find the latitude by the cross-staff with reasonable accuracy, but they had no means of finding the longitude except by the rude process of dead reckoning by the log. They had no reliable charts, and had to depend very largely either on their own personal experience of former voyages or on the advice of pilots who had sailed the seas before. It was therefore no uncommon thing at the end of a long voyage for the captain to find himself some hundreds of miles out of his reckoning—sometimes even as much as 400 or 600 miles. Thus Brouwer, in the voyage above mentioned, made Sumatra, when according to his estimated position on the chart he was still 320 miles to the westward of the island. The object of the new instructions was, therefore, to enable the ships to ascertain their position after their long run to the east. When they made the Southland they ran north along the coast until they reached the known point of Eendragt Land in 25° or 26° S. lat. From this they took a new departure, and by steering a N.N.W.

course could make pretty sure of striking the south coast of Java. The new plan led to several ships sighting various parts of the west coast of Australia in the course of the next six or seven years. Amongst others, the despatch jacht *Leeuwin*, *(Lioness)*, in 1622, doubled the Cape to which she gave her name. Even by the new route the voyage to the Indies was often very protracted, the *Leeuwin*, for instance, taking 13 months to reach Batavia. There was also the danger of overshooting the mark, as Pieter Nuyts found (1627), when in the *Gulde Zeepaert (Golden Seahorse)* he found himself at the islands of St. Peter and St. Francis, at the head of the Great Australian Bight, and had to coast back some hundreds of miles until he could round Cape Leeuwin.

The new discoveries quickly attracted the attention and interest not only of the Colonial Government but of the Home Directors, and were a frequent subject of correspondence between the Council of Seventeen and their Governors-General. As early as 1618 the Directors wrote to Governor-General Coen respecting the discovery of a great land situate to the south of Java reported by the ship *Eendragt*, Commanders Houtman, Edel, and others, recommending that ships should be sent to examine it and report on its inhabitants and resources, and the opening it might offer for profitable trade; and also to try to find a passage eastward into the Great South Sea. Accordingly, in the next few years several attempts at systematic exploration were made, but with little success. The only result was the discovery by the ships *Pera* and *Arnhem*, in 1623, of a portion of the north coast of Australia (now part of the Northern Territory of South Australia), which was named Arnhem Land, and the naming of the Gulf of Carpentaria, after the Governor-General Carpentier.

One further addition to the knowledge of these coasts was made by De Wit, whose ship, the *Vianen*, leaving the East Indies in January 1628, in the north west monsoon, was driven on to the north west coast of Australia about the Kimberley District, and who named the country De Wit Land.

The total result of these various discoveries and explorations was that the coast of Australia, from Cape York on the north to the centre of the Great Australian Bight on the south, had been traced more or less continuously by Dutch ships in the twelve years between 1616 and 1628. This coast was now called by the Dutch "The Known South Land" to differentiate it from those unexplored and supposititious regions for which, with practical sense, they retained the old appellation of "The Unknown South Land." Down to very recent times the names of these early Dutch discoveries were retained on the maps of Western Australia. Half a century ago, when across the centre of Australia was written the simple word "Unexplored," almost the only names appearing on the Western Coast were those given 200 years before by the captains of the ships of the Dutch East India Company in the early years of the 17th century. Beginning with Nuyts Land in the Great Australian Bight, and going north, we had Leeuwin Land, Edel Land, Eendragt Land, De Wit Land, and Arnhem Land. A few names still remain as evidence of the Dutch discoveries—Cape Leeuwin, Houtman's Abrolhos, Dirk Hartog's Island, and the Gulf of Carpentaria.

Such was the state of Dutch knowledge of Australia when Antony Van Diemen became Governor-General of the Dutch Indies, in the year 1636. Van Diemen was one of the most notable of the many notable men who served the East India Company in the early years of its power. Being involved in debt, he had gone to the Indies, either to escape his creditors or to retrieve his fortunes. He showed so much capacity that he was appointed Secretary to Governor-General Coen. From this time his rise was rapid. In 1626 he became one of the Councillors of the Indies, and, after important services, he was appointed Governor-General, in 1636.*

He came to his government at a time when the Dutch power had been so firmly consolidated by Coen, Carpentier, Brouwer, and others of his predecessors in office, that the Dutch were undisputed masters of the Eastern Archipelago, and had a virtual monopoly of the trade. Freed from the difficulties with the native powers and foreign rivals which had embarrassed his predecessors, he had the leisure and the means to prosecute new enterprises. His zeal for discoveries which might bring increased wealth and power to his Company was unbounded, and is shown not only by his frequent despatches on the subject to the Council of Seventeen in Holland, but by the expeditions which he planned and sent out during the term of his nine years' government.

It will be observed that the first attempts at exploration from the Dutch East India Settlements were directed to the regions east of the Banda Sea, and had for their chief object the exploration of New Guinea, and especially the determination of the question whether New Guinea and the known South Land formed one continent, or whether there was a strait between them by which access could be gained to the Great South Sea. It was to the solution of this problem that Van Diemen first applied himself in the very year in which he received his appointment as Governor-General, ignorant of the fact that the Spaniard Torres had already solved the problem by sailing through the strait that now bears his name, in the year 1606.*

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* Du Bois : *Vies des Gouverneurs Généraux*.

In the year 1636 Van Diemen despatched two ships from Banda under the command of Captain Gerrit Thomasz Pool, with instructions to proceed along the south coast of New Guinea. If, contrary to all expectation, a strait was found between New Guinea and the South Land, Pool was to sail through it and trace, if possible, the east coast of the Known South Land, circumnavigating it and returning home along Nuyts Land and Eendragt Land. If, however, as seemed most probable, New Guinea was joined to the Known South Land, he was to sail along the northern and western coasts of Australia as far south as Houtman's Abrolhos, searching all the way for any possible passage to the Pacific. More particularly was he to search the more northerly parts, as it was presumed that a strait was more likely to be found in that quarter than further south, where the South Land was presumably much wider. If Pool with some of his crew had not been murdered by the savages of New Guinea, it is possible that he might have sailed through the strait already traversed by Torres, and have anticipated Captain Cook in the discovery of New South Wales. As it happened, however, the ships returned without having discovered anything of importance. In the same year Van Diemen planned the expedition to search for the supposed "golden island," east of Japan, which three years later was undertaken by Quast and Tasman, with the result we have already seen.

2.—*The Planning of the Great Discovery Voyage.*

Governor Van Diemen's heart was now set on a complete exploration of the Unknown South Land, in which he hoped to discover a new Peru, rich in silver and gold, or at the least fertile countries inhabited by civilised people, in which might be found new and yet undreamed of commodities to bring fresh wealth into the already overflowing coffers of the East India Company. For some years domestic troubles and the want of suitable ships delayed the execution of his plans; but in the year 1641 he writes to the Council of Seventeen:—"We are very desirous to make the discovery of the South Land. The fly-ship *Zeehaen* was intended for this service, but through the strange delay of the ships from Persia and Suratte we were compelled to employ this same *Zeehaen* for the last voyage to Tayouwan and Japan. Moreover, we have kept here in the harbour idle, as much to his vexation as to our own, the renowned pilot Frans Visscher, whom we intend to employ for the discovery of the South Land; however, this shall, as we hope, be yet effected once for all."

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* The discovery of Torres remained unknown until the English took Manilla in 1762, and discovered in the Archives a copy of Torres' original letter to the King of Spain. *See* Major: *Early Voyages.*

This same Frans Jacobszoon, *alias* Visscher, took an important part as the adviser of Governor-General Van Diemen in his plans for the projected voyage of discovery. Visscher was a native of Flushing, and had been for many years in the service of the Company. He had repeatedly made the outward and homeward voyages. In 1623, as mate of the ship *Hope*, he had sailed round the world in the celebrated Nassau fleet, under the command of L'Hermite and Schapenham. He had traded in the East for many years, chiefly in the Japan trade, and was thoroughly acquainted with the coasts of Tonquin, China, and Formosa. In those days, when navigation had not been reduced to a science, and charts were either wanting or not to be depended on, the Dutch captains in the uncharted eastern seas had to place their chief reliance for safe and prosperous voyages on the personal experience of those officers and seamen who in former voyages had gained a knowledge of the coasts and rocks, the currents, and the winds of the seas they were traversing. These pilots, for the most part, were jealous of their knowledge, and indisposed to make it public, notwithstanding the repeated complaints and injunctions of the Company. Amongst these pilots, Visscher, from his long and varied experience, and from his skill and capacity, was one of the most renowned. His knowledge and experience were freely placed at the disposal of the Company, as is often made matter of honorable mention in the despatches of the Governor-General. He had made charts of the coasts and islands of the China Seas, of Formosa, the Piscadores, and Japan, and is continually referred to as one of the best chart-makers of his time. It was this man that Van Diemen consulted on the projected expedition, and, as we have seen, for this purpose he detained him—very much to Visscher's chagrin in those stirring times—for nine months in idleness at Batavia, for the benefit of his advice.

In January, 1642, Visscher wrote a report to the Governor-General on the proposed discovery of the Unknown South Land. This report is a masterly document, and gives us a high idea not only of Visscher's practical ability and knowledge as a seaman, but also of his sagacity and sound judgment. The old pilot wastes no words on fanciful speculations about the mysterious South Land. He goes straight to the point, states the conditions necessary for success, discusses possible difficulties, and, in short and concise terms, lays down a clearly defined and carefully thought-out scheme—or rather choice of schemes—for exploring both the Unknown and the Known South Lands, and, indeed, for obtaining a knowledge of the whole Southern world.

The report begins with a recommendation that the expedition should leave Batavia in August, when they would have the most favourable winds, and have the whole of the summer before them, with long days and good weather. From Batavia the ships should first proceed to Mauritius, then a Dutch possession. As the expedition was intended to go to the east, this, at first sight, seems a strange recommendation. But there were good grounds for the advice. Visscher, as we shall see, had certain reasons for wishing to make the point of departure as far to the west as possible. Mauritius, moreover, was easily reached with the south-east trades, and when there the ships would have run down nearly 1000 miles of their southing, and would have a comparatively short distance to run to the south before reaching the region of the westerly winds, on which they must depend for success. Moreover, at Mauritius, and this is the only reason explicitly stated in the report, they could conveniently take in wood, water, and other supplies necessary for the voyage.

Leaving Mauritius early in October, the ships were to get away south as quickly as possible to 51° or 54° south latitude, or until they fell in with land. From this point they should run due east upon the same latitude to the longitude of the east end of New Guinea, and then steer a course north by west until they got New Guinea on board; or else they might run further to the east to the supposed longitude of the Solomon Islands—or perhaps 500 or 700 miles beyond—then steer north, explore those islands—where, according to all accounts, they would find many things worth their trouble—and return by the north coast of New Guinea to Banda or Amboyna.

But Visscher had an alternative scheme, or rather a combination of two schemes, by which a much more complete exploration could be made. If an exploring expedition was fitted out in Holland, the ships might make the Cape of Good Hope, and thence sail south to latitude 54° S., or make Rio Janeiro, and begin from the east side of Staten Land, near Cape Horn; in either case running east to the longitude of the Solomon Islands, and making the homeward voyage as before. Such a voyage would give a knowledge of the whole Southern Ocean from Cape Horn to the Solomon Islands. Of course if land was met with the plans would be modified, but Visscher apparently had not much faith in the common belief in a huge Southern Continent, at least in the Atlantic and Indian Oceans. About the South Pacific he was more doubtful. Here the difficulty of exploration would be greater. The strong westerly winds prevailing in the latitude of Cape Horn would make it impossible for any ship to make the voyage to the west in a high latitude; but if the Dutch had a settlement in Chili, the expedition might start from there and run up into the Tropics with the south-east trades to latitude 12° or 15° S., crossing the Pacific in that latitude until it made the Solomons. If they could only be sure of getting refreshment at the Solomons this would be an excellent plan, for they could then sail south from the Solomons, and getting into westerly winds run back east to the Strait of Le Maire and Cape Horn.

By the accomplishment of these two voyages, says Visscher, "You will be able to explore the southern portion of the world round about the whole globe, and find out what is there; whether it be land, or sea, or icebergs—whatever God has ordained to be there." The old pilot's views as to the South Land, and the best means to search for it, show that he was in advance of his time, and free from many of the traditional prepossessions then common amongst navigators and geographers. If the Council of Seventeen could only have been induced to enter into Visscher's plans, the riddle of the South Land might have been solved in the 17th century, and the discoveries of Captain Cook anticipated by more than one hundred and twenty years.

These large schemes were beyond the province of the East India Government, but the plan Visscher had sketched for the expedition from Batavia was adopted in its entirety. Van Diemen in his despatches describes the voyage as having been projected on the advice of Visscher. The resolution of the Governor-General and Council decreeing the expedition is dated 1st August, 1642. It begins by stating the great desire of both the Colonial and Home Governments for the exploration of southern and eastern lands, with the hope of opening up important countries for trade, or at least of finding a more convenient way to the rich countries already known in South America. The Governor then states that he has consulted divers persons of approved judgment in such matters, and especially the renowned and most experienced pilot Frans Jacobsz Visscher, as to the explorations and the best way to accomplish them, and in accordance with their written opinions has decided to despatch for the discovery of these apparently rich countries two ships*, the *Heemskerck*, with a crew of 60 men, and the fly-ship *Zeehaen (Cormorant)*, with 50. The expedition to be under the command of the Hon. Abel Tasman, who is very eager to make the exploration; with him are to be associated the said Pilot-Major Visscher and other capable officers.

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* The *Heemskerck* was a jagt or small ship, perhaps 200 tons. The *Zeehaen* was a fluit or fly-boat, a vessel of light draught, built for quick sailing; she was smaller than the *Heemskerck*.

The ships were ready for sea. The *Heemskerck* had for skipper Ide Tjercxszoon, the *Zeehaen* Gerrit Janszoon. Tasman as commander and Visscher as pilot-major were on board the *Heemskerck*, Gilsemans the merchant or supercargo on the *Zeehaen*. In all Dutch discovery and trading expeditions the merchant or supercargo was an important personage. He had the direction of the commercial part—which in the Company's voyages was the chief part of the undertaking—and consequently had a large voice in the direction of the expedition. Gilsemans is spoken of as having a competent knowledge of navigation and as being also a skilful draftsman, and it is doubtless to his capable pencil that we owe the vigorous sketches which illustrate the original journal of the voyage.

The instructions to Tasman were printed by Swart in 1859, and are entitled, "Instructions for the Captain-Commander Abel Jansz Tasman, the Pilot-Major Franchoys Jacobsz Visscher, and the Council of the ship *Heemskerck* and fly-boat the *Zeehaen*, destined for the exploration of the Unknown and Discovered Southland, the South-East Coast of New Guinea, with the Islands lying round about." They begin with an elaborate exordium recounting the priceless riches, profitable commerce, useful traffic, excellent dominion, great might and power which the kings of Castile and Portugal had brought to their crowns by the discovery of America by Columbus and of the Cape route to the Indies by Vasco da Gama; likewise what uncounted blind heathen had thus come to the wholesome light of the Christian religion. Yet hitherto no serious attempt had been made by any Christian king, prince, or republic to explore the still unknown part of the globe situated in the south, which might be supposed to be as great as either the old or the new world, and might with good reason be expected to contain many excellent and fruitful countries, and also lands as rich in mines of precious metals as the gold and silver provinces of Peru, Chili, or Sofala. No European colony was so suitable for the starting-point of such an expedition as the town of Batavia, situated in the centre of the known and unknown Eastern India; therefore the Governor and Council of India had resolved to take the discovery in hand, and to despatch for that service the ships *Heemskerck* and *Zeehaen*.

The instructions then prescribe the course which the vessels are to take, following exactly the recommendations of Visscher's report, except that, if the ship's council for any sufficient reason thought is best, they might vary the route by making the east end of the known South Land, or the islands of St.

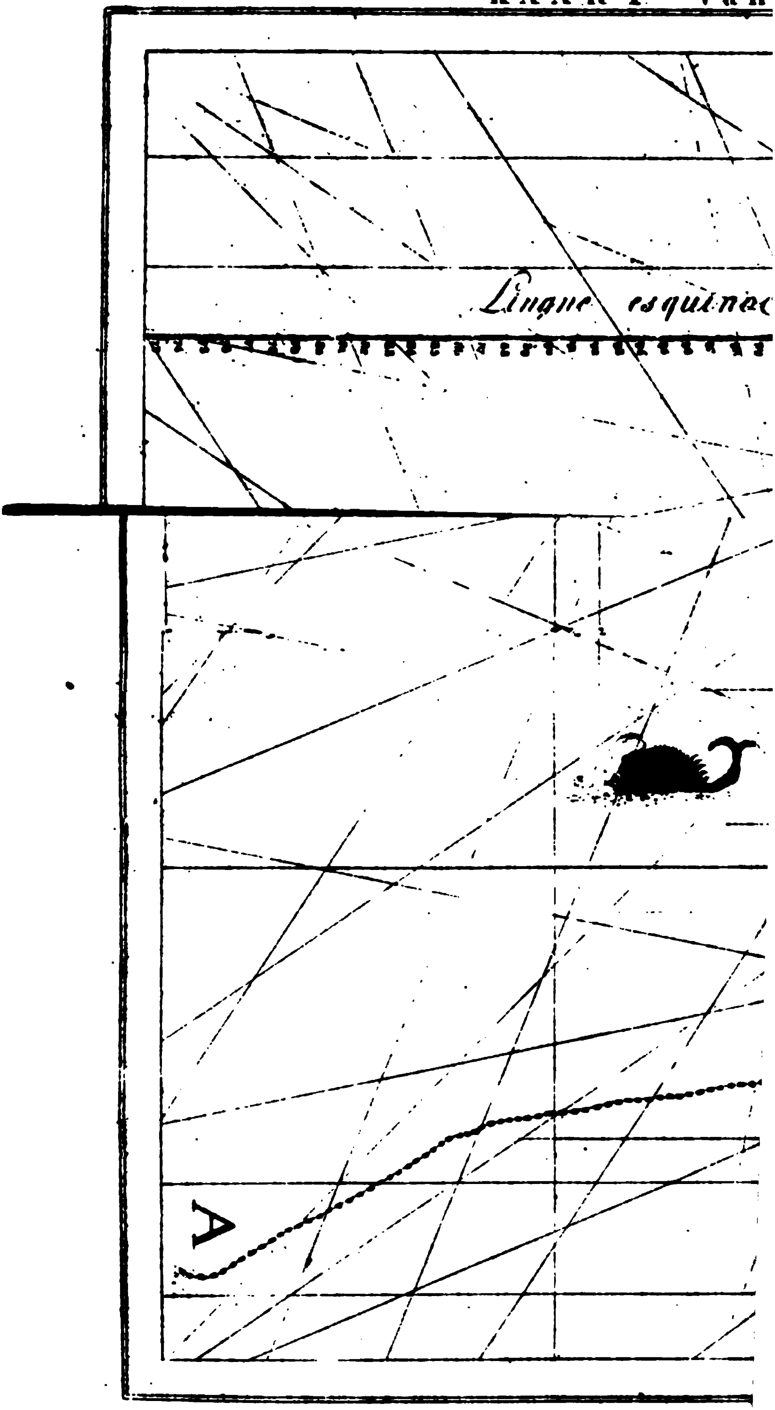
Peter and St. Francis at the head of the Great Australian Bight, and then sailing due north along the coast (which it was presumed would here turn to the north) to try to discover a passage between it and New Guinea. However, this was not recommended; the course advised being to keep on south latitude 48° to 54° until 400 to 800 miles east of the supposed longitude of the Solomon Islands, so as to be assured that there was a way through from the Indies to the South Pacific which would give a short route to Chili.

Minute directions are given for the survey and description of lands discovered; observation of winds, currents, and weather; precautions to be taken in navigation; discipline and rations of the crews; care in conciliating the natives and avoiding any injury to them; precautions to be observed against possible treachery when landing from boats; and injunctions to obtain information as to the resources of the countries visited, and the possibilities of trade with them.

It must be remembered that this, like other Dutch expeditions, was essentially commercial. It was no scientific or adventurous thirst for discovery that prompted these old Dutchmen, but plain practical business and the hope of profit for the Company. The merchant to whom was entrusted the management of the commercial venture had a large voice in the direction of the expedition. Consequently the instructions are specially precise in their injunctions to enter in the journal full particulars of the productions of the countries, what sort of goods the people had for trade, and what they would take in exchange. For this purpose the ships were laden with a great variety of articles of merchandise. Gold and silver were specially to be sought for, but, says the Governor-General with cynical candour, "Keep them ignorant of the value of the same, appear as if you were not greedy for them; and if gold or silver is offered in any barter, your must feign that you do not value those metals, showing them copper, zinc, and lead, as if those minerals were of more value with us."

Tasman was to hoist his flag on the *Heemskerck* as commander of the expedition, and was to preside in the ship's council, consisting of skippers of the two ships, Pilot-Major Visscher, the chief mates, and the two merchants. The commander had a deliberative and a casting vote. In the administration of justice the boatswains were also to be summoned and have votes. But in all matters which concerned navigation, such as courses to be steered and discovery of lands, the Pilot-Major was to have two votes, and his advice to be held in proper respect, seeing that the voyage had been projected on his advice and information. In these matters, too, the second mates were to have votes.

KAART van



In case of Tasman's death the skipper of the *Heemskerck*, Ide Tjercxszoon, was to succeed to the command.

The Instructions conclude:—"We commend you to the blessing of the Almighty, whom we pray to endue you with manly courage for the accomplishment of the proposed discoveries, and to bring you back in safety, to the increase of His glory, the reputation of the Fatherland, the service of the Company, and your own immortal honour."

They are dated Fort Batavia, 13th August. 1642, and signed by the Governor-General and his Council—Van der Lyn, Maetzuycker, Schouten, Sweers, Witsen, and Boreel.

3. *The Voyage of* 1642.

The next day (14th August) the ships sailed from Batavia, and on this day Tasman's Journal begins as follows:—"Journal or description by me, Abel Jansz Tasman, of a voyage made from the Town of Batavia, in the East Indies, for the discovery of the Unknown Southland, in the year Anno 1642, the 14th August. May it please Almighty God to grant his blessing thereto! Amen."

Sailing through the Sunda Strait, the ships carried the south-east trades with them to Mauritius, where they arrived 5th September, after an exceptionally quick passage of 22 days. An entry in Tasman's journal shows us how hopelessly abroad the best sailors in those days were in regard to longitude. He says, "By our reckoning we were still 200 miles to the east of Mauritius when we saw it." And he mentions the arrival at the same time of another ship, the *Arent*, outward bound, which had made the Island of Rodrigues in the belief that it was Mauritius, because it lay in nearly the same latitude, though 300 miles to the eastward.

They had other difficulties to contend with. A letter from Van der Stel, the Dutch Commandant at Mauritius, to the Governor-General at Batavia, states that the ships arrived in a very bad condition, and wanting almost everything. The *Zeehaen* was partly rotten, and in need of extensive repairs. Both ships were leaky, their rigging was old and weak, their yards and other spars frequently giving way. To refit the ships, caulk the seams throughout, strengthen the rigging, cut and ship spare spars, took the crews nearly a month. Meantime they took in supplies of water, firewood, and other stores; and added to their stock of provisions by shooting wild hogs, wild goats, and other game abounding in the woods. Van der Stel gave to Tasman journals and maps relating to the Solomon Islands, and vocabularies of the languages of those islands and of New Guinea. The ships were ready for sea on

4th October, but, through contrary winds, they could not get out of the harbour of Fort Fredrik Hendrik until the 8th. Taking a departure from the south end of Mauritius,* Tasman stood to the southward, getting variable winds to 31° or 32° S., when he came into the westerly winds. Passing far to the west of St. Paul's and Amsterdam, and between those islands and Kerguelen, he came, in 43° S., on floating seaweed and other indications of land. The ship's council was called together, and it was resolved to keep a man constantly on the look-out at the masthead, and to offer as a reward to whoever should first see land three reals of eight and a mug of arrack, On 29th October, three weeks out, he made 46° S. latitude, and, meeting with strong gales and fogs, thought it too dangerous to keep a southerly course for fear of falling in with land. The course was therefore changed to nearly east. On 6th November, four weeks out, he reached his highest latitude, 49° 4′ S., seeing many indications of land, which kept him anxious.

The Pilot-Major now delivered to Tasman an elaborate paper, in which he carefully discussed the future course of the voyage. He proposed that they should fall off to 44° S. latitude until they had passed the 150th meridian,† when he judged that if they had not made the Southern Continent they would be in an open sea. Then they should fall off to 40° S., and sail east to 220° longitude (about 160° W. according to our reckoning), which he judged would bring them well to the eastward of the Solomons, and enable them to make these islands with the south-east trades—as indeed it would, seeing that this would be about 15° east of the true position of the Solomons.

This resolution was communicated to the *Zeehaen* by enclosing the paper in a wooden case, and floating it astern by a long line for the *Zeehaen* to pick up. The councils of both ships having given their approval, the course was altered accordingly, and on 18th November they passed the longitude of Nuyts Land (Great Australian Bight), the furthest known extension of the discovered South Land. Here they had heavy westerly gales, and gradually fell off to lat. 42° 25′, when on the 24th November, they sighted their first land, which they called Antony Van Diemen's Land, after the Governor-General.

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* As might be expected, Tasman's longitudes are very inexact. They are reckoned east from the meridian of the Peak of Teneriffe. His longitude for the south point of Mauritius, when reduced to the meridian of Greenwich, is 3° 33′ easterly of the true longitude. Similarly, that of Batavia is 4° 23′ too easterly.

† About 130° E. of Greenwich—nearly the longitude of the head of the Great Australian Bight.

This landfall was somewhere to the north of Point Hibbs, on the West Coast of Tasmania, probably near the entrance of Macquarie Harbour—Mounts Heemskirk and Zeehan[*] being noticeable objects to the north-east. After standing off for the night, the ships next day made the land again, approaching within one Dutch mile (*i.e.*, four English miles) of Point Hibbs. By carefully comparing reckonings the longitude was fixed at 163° 50′,[†] and a new departure taken. The wind now came easterly with thick weather, so that they could not see the land. Rounding South West Cape they got the wind from the north, and sailed along the south coast. Tasman named the outlying islands and some peaks on the broken coast, which he mistook for islands, after members of the Council of India—Wit, Maatsuyker, Sweers, and Boreel. Passing between Pedra Branca and the main, and rounding the Friars (which he called Boreel Islands), south of Bruni, Tasman stood up for Adventure Bay, but was caught in a violent north-west gale, which drove the ships out to sea. From this incident the bay received its well known name of Storm Bay. Rounding Tasman's Island on the 1st December, he came to an anchor off what is now known as Blackman's Bay, but, which Tasman called Fredrik Hendrik Bay, in honour of the Stadtholder of the United Provinces. His anchorage was off Green Island, near Cape Frederick Henry on Forestier's Peninsula. Next day Pilot-Major Visscher was sent in the *Zeehaen's* boat through the Narrows to explore Fredrik Hendrik (or Blackman's) Bay. On the 3rd, Tasman with two boats made for a little bay, now known as Prince of Wales Bay,[‡] but the wind was so stiff from the south-east that the *Zeehaen's* launch with Visscher and Gilsemans on board had to run back to the ship. The *Heemskerck's* longboat with Tasman on board made the bay, but the surf was too high to allow of landing. The carpenter therefore swam through the surf, and planting the Prince's flag on shore, took formal possession of the newly discovered country.

On the 4th December Tasman weighed anchor, intending to sail northwards along the coast and take in water; the wind, however, was unfavourable, blowing from the north west, and being unable to hold the land aboard, the ship's council resolved to stand away to the east. After naming Maria Island, Schouten Island, and Van der Lyn Island (Freycinet

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[*] These mountains were so named by Flinders when he made the first circumnavigation of Tasmania in the *Norfolk* in 1798.

[†] East from Teneriffe.

[‡] Mr. Gell thinks that this Prince of Wales Bay is the Fredrik Hendrik Bay of Tasman.

Peninsula), he took his departure from "a high round mountain"—probably St. Patrick's Head, or perhaps St. Paul's Dome.*

Steering due east from the coast of Antony Van Diemen's Land, after nine days he sighted land again (13th December). This was the west coast of the South Island of New Zealand, to the south of Cook's Strait.

In an interesting paper by Dr. T. M. Hocken, of Dunedin, on Tasman's discoveries in New Zealand, it is stated that "the great high land" that Tasman first saw is situated between Hokitika and Okarito. Further north the low point described in the journal is Cook's Cape Foulwind, with its outlying rocks, the Steeples, near Westport. North of this the Karamea Bight, and the "furthermost point, which stood out so boldly that we had no doubt it was the extreme point," is Cook's Cape Farewell.

Coasting north-eastwards he made a bay on the north coast of the South Island, where he anchored. Here the Maoris in their war canoes attacked one of the *Zeehaen's* boats, killed three of the crew, and mortally wounded a fourth man. Tasman gave this bay the name of Moordenaars (or Massacre) Bay. He says, "This is the second land we have discovered; we have given it the name of the Staten Land in honour of Their High Mightinesses the States General, and also because it may be that this land is joined to Staten Land (near Cape Horn), but this is uncertain. It appears to be a very fine country. Believing that this is the main continent of the Unknown Southland, we have given this strait the name of Abel Tasman's Passage, as he has been the first to sail through it."†

Massacre Bay is near the western entrance of Cook's Strait; it is now called Golden Bay, and the scene of the tragedy, according to Dr. Hocken, lies close to Parapara.

Although Tasman noted a south-east current and suspected that there must be a passage, the weather was so bad that he did not stay to look for it; if he had done so he would have sailed through Cook's Strait and corrected his idea that he had found the Great Southern Continent. However, he sailed north along the west coast of the North Island and sighted the Three Kings Islands, on which they would have landed to get fresh water, but were deterred by seeing thirty or forty men of uncommon stature who showed themselves in a threatening attitude. He did not land in New Zealand, partly on account of bad weather and partly owing to the hostile attitude of the Maoris. After rounding the north of New Zealand he steered north-east after consultation with the ship's council, and found a great swell from the south east, which must have made him doubt the existence of the Great Southern Continent. It did indeed assure him that here was a clear passage from Batavia to Chili. Still holding a north-east course, on 21st January he came to several islands, to which he gave the names of Amsterdam, Middelburg, and Rotterdam, now known as Tongataboo, Eooa, and Annamooka, part of the Tonga or Friendly Group. He was very hospitably received by the natives, and after a few days' stay he weighed anchor (1st February), and after discovering Willems' Shoals, south east of Fiji, by the advice of Visscher and the council he stood north by west to 5° or 6° S. lat., and then west for New Guinea. He sailed along the north coast of New Guinea, and arrived at Batavia on 15th June, 1643, after an absence of ten months, during which he had lost ten men by sickness, besides the four men killed by the Maoris. His journal concludes thus: "God be praised and thanked for a safe voyage! Amen."

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* Tasman's longitudes, reduced to the meridian of Greenwich, are for Point Hibbs, 147° 11'; for the anchorage off Green Island, 150° 51'. The true longitudes are 145° 15' and 148° 1' respectively. The first shows an error of 1° 56', the second an error of 2° 50', thus making Tasmania too broad by nearly one whole degree of longitude.

In the Papers and Proceedings of the Royal Society of Tasmania for 1890, is a paper by the present writer, in which the localities mentioned by Tasman in his journal are identified and described.

† The English Admiralty has lately given to the sea between Australia and New Zealand the name of the *Tasman Sea*.

4.—*The Voyage of* 1644.

Tasman had not, as Van Diemen had hoped, discovered any rich gold or silver mines, or indeed any rich trade for the Company, but he had circumnavigated New Holland, or, as he called it on his chart, "Compagnies Nieuw Nederlandt," and had found a clear way to Chili, which opened up a good prospect for trade, or at least for great spoil to be come at from the Spanish settlements in South America. From this last Governor-General Van Diemen hoped much. On 4th January, 1644, he wrote to the Home Directory that he contemplated fitting out a fleet in September to open up a Chili trade and to plunder the Spaniards in Peru. He also intended to send two or three ships to make an examination of the newly discovered South Land, which Tasman had not found possible. For he hoped that such great countries must contain much that would be profitable to the Company, and especially gold and silver mines, as in Peru, Chili, and Japan. But, in the meantime, it would much facilitate the attempts on Chili and Peru if a shorter passage could be found between New Guinea and the Known South Land. This the Governor-General announced was to be immediately undertaken by two ships and a smaller vessel under the same commanders as before, viz.—Commander Tasman and Pilot-Major Frans Visscher; Gilsemans was again to be merchant or supercargo.

On 13th January, 1644, by resolution of the Governor-General in Council, the ships *Limmen* and *Zeemeeuw (Sea Gull)*, with the little tender *Braek (Setter)* carrying only 14 men, were commissioned for the work. They carried a complement of 111 hands, and were provisioned for 8 months. On 29th January the instructions for the voyage were drawn up and signed. They were printed in England by Mr. Major in 1859.* They contain a most interesting and valuable summary of former Dutch voyages and discoveries in the South Land. .The vessels were to coast along the south and west coasts of New Guinea to the furthest discovery in 17° S. lat. (*i.e.*, in the Gulf of Carpentaria) and endeavour to find a strait or passage into the South Sea. If a strait was found, which might be known by the south-east swell running through it, they were to sail through it and thence as far to the south-east as the new Van Diemen's Land. From thence they were to make the islands of St. Peter and St. Francis, and run along the coast of the Known Southland to DeWit Land, in 22° S. lat., when the Known Southland would be circumnavigated and be found to be the largest island in the globe. But if, as was to be presumed, New Guinea was joined to the South Land, forming one continent, then they were to run along the coast to 28° S. to the Land of Eendragt and Houtman's Abrolhos, and thence return to Batavia.

The ships sailed from Batavia next day, (30th December, 1644). The journals of the voyage are lost, and we have only the briefest notices of the expedition.† But Tasman's chart shows the route of the ships. For some reason or other, probably on account of the wind, Tasman and Visscher did not follow the instructions exactly. Instead of sailing first to New Guinea they made a straight course to the Land of Eendragt. From thence Tasman coasted northwards, and carefully charted, with soundings, the west and north coasts of Australia, including the Gulf of Carpentaria. He actually got into the mouth of Torres Strait, but did not discover the passage. Probably he was deterred from further examination by the multitude of islands and reefs that block the way, and was, moreover, ignorant of the fact that the Spaniard Torres had in 1606 sailed through the strait from the east. Failing to find the strait he returned along the south coast of New Guinea to Batavia, where he arrived in August, 1644.

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* Early voyages to Terra Australis.—Hakluyt Society, 1859.

† N. Witsen: "Noord en Oost Tartarye," translated by R. H. Major, in "Early Voyages to Terra Australis," pp. 91–98. The journal has been sought for in vain both in Holland and at Batavia, especially by Messrs. Van der Chijs and Norman in 1862.

Van Diemen in his despatch to the Home Directory, the Council of Seventeen, (23rd December, 1644), reports the result of the voyage, and expresses his discontent and disappointment that the expedition had not discovered a strait between New Guinea and the Known South Land, but only a great bay or gulf, and also that they had done nothing but sail along the coasts, and had gained no knowledge of the country and its productions, alleging as a reason that they were not strong enough to venture to land in face of the savages. This was very disappointing, since discoveries were of little use unless the country was explored at the same time. "For it is certain that so long as we merely run along the coasts and shores we shall very slowly open up anything profitable, it being well known to everybody that the coast people are ordinarily poor, miserable, and evil disposed; therefore, we must go inland." (Letter: 29 Nov.) Yet, he says, Tasman in his two voyages had circumnavigated the hitherto Unknown South Land, which was calculated to have an extent of 8000 miles of coast; and it was very improbable that in so great a country, with such a variety of climates, there should not be found something of great importance and profit for the Company. There were also the great northern lands of America, which had been made accessible by the new discoveries, and every opportunity would be taken to explore them from time to time by vigilant and courageous persons; "for," says Van Diemen, "the discovery of new countries is not work for everyone." "God grant," he concludes, "that in either one or the other [*i.e.* in North America or the South Land] may be found a rich silver or gold mine, to the satisfaction of those engaged in the venture, and to the honour of the finders."

It is plain that Van Diemen was dissatisfied with Tasman. He had looked for immediate results in the extension of trade, or at least for the finding of the New Guinea strait, and, disappointed in this, he could not appreciate the importance of the discoveries from a geographical standpoint.

Tasman's services were recognised somewhat grudgingly. By resolution of the Governor-General and Council (4th Oct., 1644) his salary was raised to 100 florins (£9 6*s*. 8*d*.) per month, and the reasons are stated in measured language:—"In which two voyages (of 1642 and 1644), he has given us reasonable contentment in respect of his services and the duties he has accomplished. It is therefore on account of this, at his request, and in consideration of his ability, also by reason of his having been again about six years in the country; and, moreover, that we find in him the spirit to render further good service to the General Council on like occasions in searching for rich countries and profitable trade."

IV.—TASMAN'S LATER YEARS, 1644–1659.

Tasman's failure to find what the Governor-General and the East India Company wanted—immediate and profitable trade—seems to have brought him under a cloud. He remained at Batavia, but without any important employment. In October, 1644, he and Frans Visscher laid down a route for an expedition fitted out to attack the Spanish ships coming from America to Manilla. But Visscher only was employed on the expedition, and Martin de Vries in a subsequent one. Tasman was passed over.

Governor-General Van Diemen died in 1645, and with him the era of great discovery expeditions closed. His successors in the government were not animated by the same zeal for exploration and adventure, but devoted their attention to strictly commercial matters, and Tasman found small opportunity for distinguishing himself. He was not wholly neglected. He was appointed (2nd November, 1644) a member of the Council of Justice at Batavia. It seems a somewhat inappropriate post for a sailor, but the special functions allotted to him may explain the appointment, for the resolution proceeds, "Commissioning and qualifying the said Tasman to demand and search for the journals of all incoming ships, and to report to us therefrom what is proper." He still held this post in December, 1646, but this did not prevent his occasional employment on more important and doubtless more congenial expeditions. Thus, in September, 1646, we find him sailing as Captain Commander in a mission to Djambi in Sumatra, and in August, 1647, going to Siam charged with letters from the Company to the King. He still kept up his relations with the Home Country, as there is mention on more than one occasion of his remitting sums of money to Holland. That he was a man of good repute amongst his fellow citizens is evidenced by the fact that in January, 1648, he was elected an Elder of the Reformed Congregation at Batavia.*

After four years of comparative inactivity, he was once more entrusted with an important expedition. On 14th May,

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* The Church Consistory at Batavia was a body which exercised a great influence in the Dutch East Indies. During the time Tasman sat as a member, a subject much discussed by the Consistory was a proposal for the suppression of Chinese idolatry, the destruction of all Chinese temples, and the punishment of the Priests. In April, 1648, the Consistory sent a Missionary, Dr. Hambrock, to Formosa, where he was shortly afterwards killed by the natives.—(Lauts, p. 290.)

1648, he took command of a fleet of eight ships, with 1150 men, which was to proceed to Manilla to lie in wait for the Spanish silver ships from America, to do what mischief it could to the enemy, and afterwards to sail to Siam. A further object was the suppression of the Chinese trade to Manilla and the extension of the Company's monopoly. The expedition was expected to accomplish great things for the Company. The Governor-General gave a dinner party to the officers on the eve of their departure, and the fleet left Batavia confident of success. The result did not justify their hopes. A descent was made on the island of Luzon (or Manilla), a number of villages and monasteries were pillaged and destroyed, and a rich booty carried off, but the main object of the enterprise was not accomplished. The Chinese trade was not suppressed, neither did the Dutch fleet capture the silver ships. One of the Dutch vessels was wrecked in a storm, and the Spanish ships contrived to escape. Tasman reached Siam in November, and the conclusion of the Peace of Westphalia, which brought to an end the Eighty Years War between Spain and the United Netherlands, put a stop to further hostilities.

The fleet returned to Batavia in January, 1649. An incident had occurred during the expedition which led to Tasman being tried before the Criminal Court, 23rd November, 1649. It is interesting, as giving us one of the few personal glimpses we have of the man, and as showing the severity with which the Company visited the delinquencies of their most valued officers, and vindicated the right of their meanest servants to a fair trial even in war time. It must be confessed that the incident does not present our navigator in a favourable light. According to the statement of the Advocate Fiscal, or prosecuting counsel, the facts were as follow:—In August, 1648, Tasman had landed at the Baviauw Islands with a military force, and had pitched a camp. He had issued orders that no one was to go outside the limits of the camp under pain of capital punishment. On the next day, "after he and some of his officers had all day been making good cheer at a certain monastery," on their return in the evening they came upon one of the supernumeraries and another sailor rambling outside the camp. Tasman was furious. He ordered the delinquents to be seized, and sentenced them to be hanged on the spot. He himself prepared the rope, and put it round the neck of the supernumerary, and made his Vice-Commander, Ogel, climb a tree and make fast the rope. This done, Tasman himself drew away the bench on which the man was standing, and left him hanging from the tree. He then made a rope ready for the second man. Luckily Ogel let go "the patient," but only just in time. Tasman made some defence, but the Court set it aside, and decided that not even the exigencies of war could excuse the Commander for hanging a man without a trial. The punishment inflicted was exemplary. Tasman was sentenced to be suspended from his office of Commander during the Governor-General's pleasure, to pay a compensation of 1000 reals to the relatives of the sailor, a fine of 150 reals, and the costs of suit. In addition to this, he was to stand bareheaded in open Court, and publicly declare that he had unjustly and unlawfully, without form of trial, of his own mere pleasure, and with his own hands, infamously executed the aforesaid innocent Coenraad Janssen of Amsterdam. It would appear that he was at the same time removed from his office in the Church Consistory—at least his name does not appear in the list of elders for the ensuing year.

The suspension from office lasted two years. In October, 1650, we find him again employed as Commander, and on the 5th January, 1651, by a resolution of the Governor-General and Council of India, he was formally reinstated in his rank, his reappointment to date from the 24th September preceding, when it is said he had again began to serve the Company.

After this time we have little information about him. It would appear that he considered his services were not sufficiently recognised, or at least that he had grievances which he laid before the Council of Seventeen in Holland. In October, 1651, the Directors ordered that a letter of complaint from Abel Jansz Tasman be enquired into and reported on, but the result of the enquiry does not appear. In January, 1653, he wrote again to the Directory, the Colonial authorities curtly noting in the margin, "Abel Jansz Tasman fails to prove his rash assertions." Whatever his grievance was, it is evident that he failed to obtain satisfaction, and that it led to his retirement from the Company's service. The daily journal of Fort Batavia two months later records, under date 15th March, 1653, the arrival at Djapara of "Ex-Commander Tasman" in his own private vessel.

Of his last days we know nothing, except that he was a substantial and well-to-do citizen of Batavia, living just outside the town on the Tygersgracht (Tiger Canal), one of the best and wealthiest quarters, and that he had considerable landed property. There were only a few larger landholders in the town, amongst them François Caron, Chief Councillor for India and Director-General, who has been mentioned as head of the Dutch Factory in Japan in 1640. Lauts found from a contemporary map of Batavia that Tasman owned a pleasure garden of nearly six acres in one quarter, and no less than 282 acres on the Tiger's Canal, where he resided. Nieuwhoff, who was in the Indies from 1654 to 1670, says that the handsomest buildings in Batavia were situated on the Tiger's Canal, which was planted on both sides with fine trees. Valentyn says: "The view of this straight canal, so beautifully planted, surpasses anything I have ever seen in Holland."

On 10th April, 1657, Tasman made his will, which is still preserved in the Registry of the Probate Court of Batavia. It opens with the quaint old formula, "In the name of God, Amen!" and states that the testator is up and about, sick in body, but having good memory and understanding, and being used to think upon the shortness of life, that there is nothing more certain than death, and nothing more uncertain than the hour of the same, he has therefore resolved to make a solemn testament. First he beqeaths twenty-five guilders to the poor of Luytgegarst, his native village; secondly to Abel Heylman, his daughter's son, living in Batavia, a gold cup and silver-mounted sword. All the remainder of his property he gives to his beloved wife, Joanna Tjercx. If however she marries again, half of her bequest is to go over to the children of his only daughter, Claesjen. If his daughter or her children dispute the will, or require accounts from the widow, then their half share is to be reduced to one-fourth (the ordinary legal portion of a child). After his widow's death the half is to fall to the children of Claesjen; but as to the widow's half she may use and treat it as her own free property without contradiction of any.

Tasman had no children by his second wife, Joanna Tjercx. Claesjen was the daughter of his first wife, Claesgie Heyndricks. Claesjen had been twice married and had children by both husbands. The first, Philip Heylman, held an important office in the Fort; the second, Jacob Breemer, was an officer of the Probate Court of Batavia.

In October, 1659, the will was deposited in the Probate Court of Batavia; so that Tasman must have died in that year, fifteen years after his second great voyage.

The great navigators have seldom been long lived. Magellan and Cook died at fifty-one, Vasco da Gama at fifty-six. Tasman reached the latter age.

His widow, though forty-seven years old at her husband's death, did not long remain unconsoled. Eighteen months later, under date 5th February, 1661, the daily journal of Batavia records that permission was granted for the marriage of Jan Meynderts Springer, burgher of Batavia, to Madame Anna Tjerks, widow of the deceased Commander Abel Tasman, to be celebrated at her sick bed in consideration of her severe illness; Springer to pay to the Church a hundred reals of eight for the privilege.

It remains to mention the well-known story of Tasman's supposed attachment to a daughter of Governor-General Van Diemen, evidenced by his naming various places, *e.g.* Cape Maria Van Diemen, Maria Island, Maria Bay at Tonga. Flinders first suggested this little romance in his Voyage to Terra Australis, published in 1814. It pleased the fancy of the French geographer Eyriès somewhere about 1820, and has been repeated and enlarged upon for some eighty years.

It is a pretty story, but unfortunately for the romance it has not the slightest foundation. In the light of recent investigations Tasman appears as a twice-married man of middle age, with a grown-up daughter. But this is not conclusive. Perhaps the next argument against the story is more cogent: Van Diemen had no daughter. If, however, anyone is still unconvinced, we may clinch the argument with the express statement of Tasman attached to one of the drawings in his Journal:—"We have named this bay Maria Bay in compliment to the wife of Governor-General Van Diemen." If anyone after this requires further proof, let him consult the papers of the Dutch East India Company, or continue to write sentiment on the ardent young sailor's unrequited love.

To conclude. Tasman's discoveries, great as they were from a geographical point of view, bore no fruit for more than a hundred years. His tracks were marked on the charts, but as to the countries he discovered, his countrymen in the East Indies, whose sole object was trade, felt no temptation to explore the wild bush of Van Diemen's Land, or to face the fierce tribes of Massacre Bay, or even to plant colonies on the barren and inhospitable shores of Western Australia peopled by naked savages. Only the Englishman Dampier in 1688, and again in 1699, visited the western coast, and was glad to leave what he described as the most miserable country on earth. Had Tasman but discovered the way through Torres Strait, it is possible that New South Wales might have been colonised by the Dutch. It was reserved, however, for an English navigator, more than a century after Tasman's voyage, to make the practical discovery of Australia as a land for European colonisation. When Captain Cook in his first famous voyage in the *Endeavour*, on Sunday, 29th April, 1770, cast anchor in Botany Bay, the Australian Continent was first laid open to European enterprise; eighteen years later Sydney was founded by Englishmen. Would that the first planting of these Colonies had been other than it was, and that the wise warning of Lord Bacon had been heeded; for, says he—"It is a shameful and unblessed thing to take the scum of the people and wicked condemned men to be the people with whom you plant; and not only so, but it spoileth the plantation, for they will ever live like rogues and not fall to work, but be lazy, and do mischief, and spend victuals and be quickly weary, and then certify over to their country to the discredit of the plantation." All which things were verified in the early history of these Colonies. But Australia "has burst her birth's invidious bar, and grasped the skirts of happy chance; breasted the blows of circumstance, and grappled with her evil star; has made by force her merit known, and lived to clutch the golden keys." A hundred years growth has now made Australia well nigh a nation; but as yet it is a nation in the gristle only. When the petty jealousies of the Colonies are laid aside, and when the several States—as we hope may soon be the case—are united in one great Federation, we may feel a perfect confidence that, amongst the children of the old English mother, not the least important will be those dwelling in the island Continent circumnavigated by Tasman two hundred and fifty years ago, who will claim the title of Citizens of the Commonwealth of Australia.

BIBLIOGRAPHICAL NOTES.

MAPS OF THE VOYAGES, 1642 AND 1644.

Manuscript Maps.

1. In the collection of Van Keulen of Amsterdam. A large and handsome map on Japanese paper, showing both voyages. Mr. Leupe thinks it to be the work of Pilot-Major Visscher. Australia bears the name of *Compagnis Nieu Nederlandt.* This map was reproduced in coloured facsimile in Mr. Swart's edition of the complete journal published in 1860.
2. In the British Museum. Sloane MSS. 5222, Art. 12. A large sketch map, roughly executed, showing both voyages. In the centre of Australia is written "This large Land of New Guinea was first discovered to joyne to ye South Land by ye Yot Lemmen as by this Chart Ffrançois Jacobus Vis. Pilot Maior Anno 1643." Mr. Major, who gives a reduced copy of this chart in his *Early Voyages*, thinks it to be a copy of a map by Visscher, and that it was made by Captain Thomas Bowrey, of Fort St. George, about 1687. Mr. Alfred Mault, of Hobart, has made a facsimile of the original map, and this has been photo-lithographed for the Royal Society of Tasmania.
3. In the India Museum, South Kensington. A coloured chart of the coast of Van Diemen's Land, endorsed in an old hand: "A Draught of the South Land lately discovered, 1643." Mr. A. Mault found this chart amongst the Records of the India Office. He contributed to the Transactions of the Australasian Association for the Advancement of Science, 1892, a description of this map with coloured facsimile.

Early Maps.

In 1648, four years after Tasman's second voyage, the building of the new Stadhuis, or Town Hall, of Amsterdam was begun. The opportunity was taken to commemorate Tasman's discoveries by showing them in a great map of the world in two hemispheres, cut in the stone pavement of the Great Hall (Burgerzaal) of the Stadhuis. This pavement has long since been boarded over.

Mr. Major says that an outline of the coast visited by Tasman is given in Turquet's Mappemonde, published in Paris in 1647; also in the 1650 edition of Janssen's Atlas, and in the 1660 edition of J. Klencke's Atlas. The discoveries are also shown in Fredk. de Wit's map, published in 1660; and a representation of the hemispheres is given in the fine work describing the Stadhuis, and published in 1661. The map in Thévenot (1663) is from the Stadhuis pavement, but with names added. Some of the published maps contain the names Hollandia Nova and Zeelandia Nova.

MANUSCRIPTS OF THE JOURNAL OF 1642.

Mr. Leupe describes three contemporary manuscripts which are preserved in Holland :—

1. R.A. 1. In the State Archives at the Hague. Consists of 28 double folio leaves, bound in a volume which forms part of a collection made by Cornelis Sweers. It is badly written and kept in a slovenly manner, probably by a young officer on board the *Heemskerck*.
2. R.A. 2. In the State Archives. In a large folio volume containing 196 pages, very neatly written, with a large number of charts and drawings, some coloured. It bears the autograph signature of Tasman, and is apparently a fair copy of the official journal kept on board the *Heemskerck*. It is probably the manuscript used by Valentyn in compiling his account. He reproduced most of the maps and sketches. This manuscript, with the charts and drawings, is to be reproduced in facsimile in Messrs. Fred. Muller & Co's. forthcoming edition.
3. H. v. M. In the possession of Mr. Huydecoper van Marsseveen. In a folio volume, smaller than R.A. 2, contains 112 pages, neatly written, with three small charts and some sketches. It also is a copy of an original journal, and is not signed. It has some particulars not given in R.A. 2. It is from Cornelis Sweers' collection.

The following manuscripts are also known :—

4. Brit. Mus. 8946. Plut. C.L. xxii. D. In the British Museum. It is carelessly written, and contains 38 charts and sketches. Probably a copy of R.A. 2. This manuscript was bought in London at Mr. Lloyd's sale, some time before 1776, for half-a-guinea, and was subsequently acquired by Sir Joseph Banks. In 1776 Banks employed the Revd. Charles G. Woide, Chaplain of the Dutch Chapel at St. James's, to translate it. Woide's translation was used by Captain Burney in his work. About 1868 the late Mr. J. E. Calder published in the *Tasmanian Times* the account of the discovery of Tasmania taken from Burney.
5. Amongst the hydrographical documents belonging to the publishing firm of Van Keulen of Amsterdam, there was formerly a manuscript copy of the Journal. It was probably a copy agreeing with R.A. 2, and, it is said, bore Tasman's signature. Mr. Swart printed the complete Journal from this copy, 1854-59.
6. Mr. Lauts mentions that a manuscript copy of the Journal was bought by the bookseller Bom, of Amsterdam, in 1835.

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   [The first published abstract of the Journal. Nos. 2 to 9, are translations of this.]
2. Hooke, Dr. Robert—Philosophical Collections. 4to. London, 1678.*
3. Thévenot, Melchisedek—Relation de divers voyages curieux. Nouvelle edition. 2 vols., fol.: Paris, 1696.
   [The first edition 1663-72 contains the map only. The voyage was printed as a supplement, circa 1681.]
4. An Account of several late Voyages and Discoveries. 8vo: London, 1694. 2nd edition, 1711. [Narbrough's Voyage, &c.]
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6. Campbell, Dr. John—Navigantium atque itinerantium bibliotheca, by John Harris. 2 vols, fol.: London, 1744-48. [With notes and map].
7. Voyages de F. Coreal aux Indes Occidentales. 3 vols., 12mo: Amsterdam, 1722: Paris, 1738. [The voyage is appended as a supplement].
8. Brosses, Charles de—Histoire des Navigations aux Terres Australes. 2 vols., 4to: Paris, 1756. [With Vaugondy's map of Australasia].
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11. Prévost, L'Abbé Antoine François—Histoire générale des Voyages. 19 vols., 4to: Paris, 1746-70.*
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14. Dalrymple, Alexander—Historical Collection of the several Voyages and Discoveries in the South Pacific Ocean. 2 vols., 4to: London, 1770-71. [The text is taken from Valentyn, collated with Nos. 2, 3, 4, 6, and 12].

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Wite Eijlanden
Swerte Eijlanden

APPENDIX.

THE DISCOVERY OF TASMANIA.

From Tasman's Journal, 1642.*

23rd November.†—Good weather, and the wind S.W., with a fresh gale. In the morning found that our rudder-head was broken in two in the tiller-mortise; whereupon lay to under shortened sail, and put a plank on either side. Noon, found our latitude 42° 50′, and longitude 162° 51′. Course held E., and sailed 25 (100) miles. Here found one degree north-westerly variation, which here decreases very rapidly. According to our reckoning had the west side of *Nova Guinea* to the north of us.

24th November.—Good weather and clear sky. Noon, found latitude 42° 25′, and longitude 163° 31′. Course kept E. by N., and sailed 30 (120) miles. The wind from the S.W., and afterwards S., with a gentle top-gallant breeze. Afternoon, about 4 o'clock, saw land. Had it E. by N. from us 10 (40) miles by our reckoning. It was very high land. Towards evening saw in the E.S.E. three high mountains, and in the N.E. also saw two mountains, but not so high as those to the south. Here had a true pointing compass. In the evening, in the first glass when the watch‡ was set (8 P.M.), proposed to the council of our ship with the under mates, whether it would not be best to stand off the shore to sea; and required their opinion, when they thought this to be most advisable. Whereupon unanimously approved after 3 glasses (9·30 P.M.) to lie out from the shore and run from it 10 glasses (5 hours), when we should stand back to the land: all more fully appearing in the resolution of this date to which we refer. At night, after 3 glasses (1½ hours), the wind was S.E. Tacked from the shore, and sounded in 100 fathoms, clean white fine sand with small shells; afterwards sounded again, and had black coarse sand with small stones. At night had the wind S.E. with gentle breeze.

25th November.—Morning, nearly calm. Hoisted the white flag and the flag at the mizzen-top-gallant-mast, whereupon the officers of the *Zeehan* with their mates came on board us, when we called the council and resolved with them, as is to be seen by the resolution of this day, and is there set out at length, to which we here refer. Towards noon got the wind S.E., and afterwards S.S.E. and S. Tacked for the shore. In the evening, about 5 o'clock, came under the shore. Three miles (12) out from the shore had 60 fathoms, coral bottom; 1 mile out (4 miles) had clean fine white sand. Found this coast stretching S. by E. and N. by W., a smooth [bare] coast, and had reached latitude 42° 30′, and mean longitude 163° 50′. Tacked again from the shore. The wind blew S.S.E., top-gallant breeze. When you come from the W. and find that you have 4° north-westerly variation, then you may look out for land, because the variation here decreases very rapidly. If it happens that you get rough weather from the westerly quarter, then you may well lie to, and not sail ahead. Here on the coast you have a compass pointing true. We have also the mean longitude, which we determined by each working out his reckoning and taking the mean. Wherefrom we find this land to be in the longitude of 163° 50′.

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* Translated from Swart's edition of the Journal, with notes, &c., published at *Amsterdam* in 1860. A strictly literal translation has been preferred, as giving a better idea of the quaintness of the original.

† The days are reckoned from midnight to midnight. The longitude is calculated from the meridian of the *Peak of Teneriffe.*

‡ The first watch was from 8 P.M. to midnight. A half-hour sand-glass was used to measure the time.

This land is the first land in the *South Sea (Zuytzee)* that we have met with, and is yet known by no European nations. So we have given this land the name of ANTHOONY VAN DIEMENSLANDT, in honor of the Most Honorable the Governor-General, our High Master, who sent us out to make these discoveries. The islands lying round about it, as many as are known to us, we have named after the Honorable Members of the Council of India, and may be seen on the small chart made thereof.

> [Here there are in the manuscript some sketches of land, of which two are found in VALENTYN, p. 48, No. 1A and No. 5E. The other, No. 5E, I have not found in the manuscript.—JACOB SWART.]

26th November.—Had the wind easterly, gentle breeze, hazy weather, so that we could not see land. Reckoned we were about 9½ (38) miles from the shore. Towards noon, hoisted the flag at the main-top-gallant-mast, whereupon the *Zeehaen* immediately came up under our stern, when we hailed her people that Sr. GILSEMANS should come aboard. Whereupon the said GILSEMANS without delay came on board us, and we made known to him the matters which are mentioned in the under-written note, and are to be taken with him to his ship, in order to show the same to the Skipper, GERRIT JANSZ, and also for orders to their mates.

"The officers of the fly-ship *Zeehaen* shall in their daily log describe this land, which we saw yesterday and are now near, as in longitude 163° 50′—because by mutual reckoning we find it thus, and this longitude as settled—and begin to reckon the longitude afresh from thence. He who before this has longitude 160° or more, shall now make his reckoning from that land. This is therefore done in order to avoid all mistakes as much as is in any way possible. The officers of the *Zeehaen* shall give the same charge to the mates, and shall also observe it, because we find this to be fitting; and the charts which are hereafter made by any one shall lay down that land in the mean longitude as before stated of 163° 50′.

"Given on the *Heemskercq*, date as above.

"(Undersigned) Abel Jansz Tasman."

Noon, reckoned we were in S. latitude 43° 36′, and longitude 163° 2′. Course kept S.S.W., and sailed 18 (72) miles. Had half a degree north-westerly variation. Got the wind N.E. Set our course E.S.E.

27th November.—Morning, saw the coast again. Our course was still E.S.E. Noon, reckoned we were in S. latitude 44° 4′, and longitude 164° 2′. Course held S.E. by E., and sailed 13 (52) miles. It was drizzling, misty, hazy, and rainy weather; the wind N.E. and N.N.E., with gentle breeze. At night, after 7 glasses in the first watch (11·30 p.m.), lay to under shortened sail. We dared not sail on, by reason that it was so dark.

28th November.—Morning, still cloudy, misty, rainy weather. Made sail again. Set our course E., and afterwards N.E. by N. Saw land N.E. and N.N.E. from us, and stood straight for it. The coast here stretches S.E. by E. and N.W. by W. This land runs away here to the east so far as I can observe. Noon, by reckoning in latitude 44° 12′, and longitude 165° 2′; and course held E. by S., and sailed 11 (44) miles. The wind from the N.W., with gentle breeze. In the evening came under the shore. There are under the shore some small islands, one of which looks like a lion. This lies about 3 (12) miles out to sea from the mainland. Evening got the wind E. At night lay to under shortened sail.

29th November.—Morning, were still near the rock which looks like a lion's head.* Had the wind westerly, with topgallant breeze. Sailed along the coast, which here stretches east and west. Towards noon passed two rocks, the most westerly looking like *Pedra Branca*, which lies on the coast of *China*; the most easterly, looking like a high rugged tower, lies about 4 (16) miles out from the mainland. Ran through between these rocks and the land. Noon, reckoned we were in latitude 43° 53′, longitude 166° 3′. Course held E.N.E., and sailed

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* The *Mewstone*.

12 (48) miles. Still sailed along the shore. In the evening, about 5 o'clock, came before a bay.* It seemed that we would likely find a good anchorage there. Wherefore resolved with our ships' council to run into it, as appears by the said resolution. Were almost in the bay when there presently arose such a violent wind that we were obliged to take in our sails and run back to sea under shortened sail, because it was impossible with such a wind to come to an anchor. In the evening resolved to stand out to sea for the night under shortened sail that we might not fall on a lee shore in such a storm. All which is to be seen more at large in the above-mentioned resolution, whereto (to avoid prolixity) we here refer.

Ultimo November.—Morning, at dawn, tacked to the shore. Had been driven off from the shore so far by wind and current that we could scarcely see land. Did our best to approach it again. Noon, had land N.W. from us; tacked to the west, the wind northerly, but not serving us to fetch the land. Noon, found latitude 43° 41′, longitude 168° 3′. Course held E. by N., and sailed 20 (80) miles, with stormy and unsettled weather. Here the compass showed true. A little after noon tacked to the west, with hard unsteady breeze. Tacked to the north under shortened sail.

Primo December.—Morning, weather somewhat more moderate. Set our topsails; the wind W.S.W., with top-gallant breeze. Steered our course for the shore. Noon, found latitude 43° 10′, and longitude 167° 55′. Course held N.N.W., and sailed 8 (32) miles, and was almost calm. At noon, hoisted the white flag, whereupon our friends of the *Zeehaen* came on board, when we resolved together that it would be best and most expedient, if wind and weather but permitted, to get on land, the sooner the better, so as to obtain a nearer knowledge of its situation, and also to see what refreshments were to be had, as the resolution of to day shows more at large. Afterwards got a little breeze from the eastward. Ran towards the shore to examine whether some good anchorage can be got hereabouts. About an hour after sunset let go the anchor in a good harbour, in 22 fathoms, between white and grey fine sand, good holding ground; for which we must show thankful hearts to Almighty God.

[Here in TASMAN's Journal is the little map found in VALENTYN, pp. 48, 49. The degrees of longitude in VALENTYN differ one whole degree from those in TASMAN's Journal. Also the two little ships of the latter are not found in the little map in the Journal.—JACOB SWART.]

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* *Storm Bay, or rather, Adventure Bay.*

2nd December.—Early in the morning sent the Pilot-Major, **Francoy Jacobsz**, with our long-boat (*chaloup*), with 4 musketeers and 6 rowers, every one provided with a pike and sidearms, together with the launch (*praeutien, sloep*) of the *Zeehaen*, and one of their second mates and 6 musketeers, to an inlet (*inwijck*), which was situated fully a long mile (*i.e.*, over 4 miles) north-west of us, in order to see what useful things—such as fresh water, refreshments, timber, and other things—might be obtainable there. About 3 hours before evening our boats returned, bringing various samples of vegetables, which they had seen growing in abundance, some not unlike certain herbs which grow at the *Cabo de Bona Esperance* (*Cape of Good Hope*), and are fit for use as pot herbs. Others were long and saltish, which have no ill-likeness to sea-parsley. The Pilot-Major and the second-mate of the *Zeehaen* reported what follows, namely :—

That they had rowed above a mile (4 miles) to the said point, where they had found high but level land with herbs (not planted, but springing from God and nature), fruitful timber in plenty, and a running watering place, and many open valleys ; which water was good indeed, but very troublesome to draw, and running so slowly that it could only be taken out with a bowl.

That they had heard some sound of people ; also a playing nearly like a trumpet or small gom [gong], which was not far from them, but they had not got to see anyone.

That they had seen two trees about 2 to 2½ fathoms thick, 60 to 65 feet high below the branches, which trees had been hacked into with flints, and the bark peeled off in the form of steps (in order to climb up thereby and take birds' nests), each being full 5 feet from the other. So that they presumed that there were very tall men here, or that they must know how to climb the said trees by some device. In one tree these cut steps seemed so fresh and green as if not four days had passed since they had been hewn.

That they had observed in the earth footprints or scratchings of some beasts, not ill-resembling the claws of a tiger. They also brought on board some dung of four-footed beasts (as they presumed and could observe), besides a little gum, fine in appearance, which drops out of the trees, and has a resemblance to gumlac (*gomma lacca*). That about the east point of this bay, having sounded at high-water, they had found 13 to 14 feet ; the ebb and flood there about 3 feet.

That in the entrance of the said point they had seen a multitude of gulls, wild ducks, and geese, but none landward ; though they had indeed heard the noise of them ; and had observed no fish, but divers mussels sticking in sundry places on bushes, That the country is generally occupied with trees, which stand so thinly scattered that you may pass through everywhere and see to a far distance; so that you could always get sight of people or wild beasts in the country, as it is unencumbered by thick wood or underwood; which should give great facility for the exploring of the country.

That in various places in the interior they had seen many trees which had been deeply burnt into above their roots. The earth was here and there beaten down and burnt as hard as stones by the lighting of fires on it.

A little before our boats (which were coming on board) got within sight, we saw at times a thick smoke rising on the land, which lay about W. by N. from us. We therefore presumed that our people were doing it for a signal, because they were delayed so long in returning; for they had their orders to come back to us with speed, partly in order to inform us of their discoveries, or otherwise, if they saw there was nothing useful there, that they might go to examine other places, so that no time should be spent uselessly. Our people having come on board we asked them whether they had been thereabouts and had lighted fires, whereupon they replied that they had not, but that at divers times and places in the woods they also had seen smokes; so that without doubt there must be men in this place, and these of an uncommon stature.

To-day, had much variable wind from the eastward, but the most of the day a stiff steady gale from the S.E.

3rd December.—To-day we went with the Merchant GILSEMANS and our boats, as yesterday, with musketeers, the rowers being provided with pikes and side arms, to the S.E. side of this bay. Where we found water, but the land so low that the fresh water was made brackish and salt through the breaking of the sea, and the ground was too rocky to sink wells. Therefore returned on board, summoned the council of our two ships, with whom we resolved and found to be good, as is shown by the resolution of this date, where it is to be seen at length and is set forth; whereto for brevity's sake we here refer. Afternoon, we went with the said boats, together with the Pilot-Major FRANCOYS JACOBSZ, the Skipper GERRIT JANSZ, ISACK GILSEMANS, Merchant of the *Zeehaen*, the Junior Merchant ABRAHAM COOMANS, and our Chief Carpenter PIETER JACOBSZ, to the S.E. corner of this bay, having with us a pole with the Company's mark cut therein, and the Prince's flag, in order to set the same up there, so that it may be evident to posterity that we have been here and taken the said land for a possession and property. Having rowed with our boats about half way, it began to blow hard and the sea to rise so high that the launch of the *Zeehaen*, in which were the Pilot-Major and Sr. GILSEMANS, was obliged to return on board. We went on with our long-boat (*chaloup*), coming close under the shore into a little bay which lay W.S.W. from the ships. The surf broke at such a rate that the land could not be approached without danger of the boat being dashed in pieces. We ordered the said carpenter to swim ashore by himself with the pole and Prince's flag, and remained with the long-boat lying to the wind. We made him set up the said pole with the flag at the top in the earth before a decaying tree, the lowest one of a group of four noticeable high trees standing in the form of a crescent about the middle of this bay. This tree is burnt just above the foot, and is indeed the tallest of the other three,* though it appears to be not so high, since it stands on the declivity of the cluster. It has at the top above its crown two high dry branches sticking out, so uniformly set about with dry twigs and branchlets that it looks like the great horns of a stag. Moreover, on the undermost side there stands a very green and round well-crowned branch, the shoots of which, by their even proportion, made the said tree very elegant and like the top of a larding pin. After the head carpenter had accomplished the matter above rehearsed, in view of me, ABEL JANSZ TASMAN, the Skipper GERRIT JANSZ, and the Junior Merchant ABRAHAM COOMANS, we rowed the boat as near to the shore as we dared venture, and the said carpenter swam back again to the long-boat through the surf; when, after accomplishing this matter, we rowed back again on board, leaving the above-mentioned as a memorial to posterity and to the inhabitants of this country, who did not show themselves, although we suspected that some of them were not far from there, and kept watchful eyes on our proceedings.

We did not look for herbs, for on account of the roughness of the sea no one could reach the shore save by swimming, so that it was impossible to bring anything to the long-boat. All day the wind was mostly northerly. In the evening took observation of the sun, and found 3° N.E. variation. With sunset got a strong north wind, which rapidly increased to so violent a storm from the N.N.W. that we were constrained to strike both yards and to let go our bower anchor.

4th December.—With the dawning of day the storm abated. The weather moderate, and the wind being off shore W. by N. Hove in the bower anchor again. The said anchor being hove up and got above water, saw that both flukes were so far gone that we got home nothing but the bare shaft. Weighed the other anchor also, and got under sail, in

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* *Sic* in original.

LIST OF THE DESCRIBED PLANTS O SMANIAN ROCKS,
SHOWING
CO

FOSSIL PLANTS.	RBONIFEROUS PALÆOZOIC).			
	UPPER MARINE BEDS.	LOWER COAL MEASURES.	TASMANITE BEDS.	LOWER MARINE BEDS.
FILICES.				
Alethopteris Australis				
„ serratifolia				
Cardiopteris Tasmanica				
Cyclopteris? Australis*				
Danæa Morrisiana				
Gangamopteris augustifolia		—		
„ cyclopteroides, var. attenuata ..		—		
„ „ „ sub-auriculata		—		
„ obliqua		—		
„ spathulata		—		
Gleichenia dubia				
Glossopteris ampla		—		
„ Browniana		—		
„ communis		—		
„ elongata		—		
„ reticulum		—		
„ moribunda				
„ ovata		—		
„ spathulato cordata		—		
Macrotæniopteris wianamattæ				

FURTHER CONTRIBUTIONS TO THE HISTORY OF THE FOSSIL FLORA OF TASMANIA.

PART II.

BY R. M. JOHNSTON, F.L.S.

(*Read May 20th*, 1895.)

The second of this series of contributions to the history of our Fossil Flora refers largely to collections of plants made by the Rev. J. Bufton, F.L.S., from Upper Mesozoic coal measures shales in the neighbourhood of Dunally, which collection this accomplished naturalist kindly placed at my disposal. It will be seen from the notes, descriptions, and figures which follow that I have been enabled by these collections to add to the list several interesting plant forms new at least to our Tasmanian Fossil Flora.

With one or two of the forms, new to science, it has afforded me great pleasure to associate the name of the discoverer.

I am indebted also to my friend, A. Montgomery, M.A., F.G.S., our Government Geologist, for more perfect specimens of three species of undescribed, or imperfectly described, fossil plants occurring in the coal measures of Fingal, Seymour, and York Plains.

By the more perfect examples, thus obtained, I have been enabled to add a new genus to our list (*Strzeleckia*) of Mesozoic plants, and also three new species. I had long been on the outlook for perfect examples of these forms, which I recognised many years ago; but the specimens in my possession hitherto were too imperfect to determine their specific characters satisfactorily.

I have also added to the list one or two interesting forms obtained by myself some years ago from shales of Upper Mesozoic Age at Lord's Hill, New Town, and elsewhere.

I have in a separate table prepared a complete classified list of all the species of fossil plants known to me of Permo-carboniferous and Mesozoic Age which have been described to date, including those new forms described in this contribution. This table (embracing 75 species) is also arranged to show what I now conceive to be the probable order of succession of the principal groups and formations; and against each are recorded their respective floras for the benefit of the stratagraphist and the mining expert.

Strzeleckia, nov. gen.

Frond simple; form variable; now equilateral or inequilateral; now oblique, falcate, or symmetrical; now elongate-lanceolate, elongate-spathulate, or linear-lanceolate, and in rudimentary forms, frequently wide, inequilateral, oblique, and subtrigonal. In all forms there is a gradual tapering towards the base to a linear strap-shaped petiole, which is more or less amplexicaul; no mid-rib; nerves numerous, distinct, ascending from base, and from the crowded mid-rib-like central series, at a very acute angle to the margin, but *never anastomosing*. The central series become less crowded towards middle, and, towards apex, the central series spread out and diverge symmetrically as in the lateral series.

This genus—evidently a tufted form—comes near to *gangamopteris* in all characteristics, from which it is distinguished by the total absence of nerve anastomoses.

So far as known this genus is confined to the Upper Mesozoic coal measures, and occurs commonly in the upper coal measure shales at Mount Nicholas and Spring Bay.

Strzeleckia gangamopteroides. (Nov. sp. Figs. 5-7.)

Frond simple, variable, possessing all the characteristics of the genus, save that it is never linear, as in the following species.

Mature form generally broadest above the middle; apex obtusely pointed. Greatest length from 4 to 4½ inches; greatest breadth, about three-quarters of an inch. Lateral or oblique rudimentary forms; greatest length, 2¼ inches; greatest breadth (middle), ⅞ inch.

Locality, Mount Nicholas coal measures, Tasmania (common).

In Plate 26, Fig. 2, "Geology of Tasmania," I referred a doubtful form to *Pecopteris caudata* (Mihi), but the specimens thus referred to did not show the neuration clearly. I am now confident that it should be referred to *S. gangamopteroides.*

Strzeleckia tenuifolia. (Nov. sp. Fig. 8.)

Form simple, almost symmetrical, elongate, linear-lanceolate; apex obtusely accuminate, very gently narrowing to a long attenuate, and slightly oblique petiole. Nerves distinct, not so crowded as in the preceding species (*S. gangamopteroides*), ascending acutely to margin.

Greatest length 4¼ to 4½ inches, greatest breadth ⅛ inch.

Locality, Mount Nicholas coal measures, Tasmania (common).

Sphenopteris Morrisiana, (Nov. sp. Figs. 14, 15.)

Frond large (imperfect), bi-pinnate, deltoid, or lanceolate-deltoid, probably 2 to 3 feet long in completed state, and about 8 or 9 inches across towards base; *stipe*, rounded and firm; *pinnæ*, somewhat distantly placed; spaces varying from 1¼ inches in the upper portion to 1½ and even 2 inches in the lower, generally ascending in a gentle curve from rhachis at an angle of 45°-50°. *Pinnæ* broadly linear-lanceolate, opposite in the upper portion of frond and alternate in the lower. *Pinnules* numerous, somewhat distant, sub-opposite, variously lobed, linear-lanceolate and generally wavy or falciform. The series on upper side of rhachis are somewhat erect, and are directed towards apex of frond, overlapping about ¼ of the lower series, which curve forwards towards extremities at a more acute angle. Each pinnule gradually broadens towards base, where it is suddenly rounded and constricted, and becomes almost petiolate. The basal-lobe of upper side is bent or inflated into an auricle, whose lower margin runs almost parallel for some distance with the rhachis. The rounded basal-lobe of lower side is cut away more sharply. Each side of pinnule is incised to about half of its breadth by a number of ovately-rounded lobes, usually with a dentate or obscurely trilobate terminal. The number of pairs of lobes diminishes as the pinnæ approach apex of frond, where they are finally reduced to four, and even three pairs of lobes, with the usual dentate or obscurely trilobate terminal. The nerves vary with the lobes in the number and in complexity of furcation. Each pinnule is characterised by a firm wavy mid-rib, which only evanesces in the terminal lobe; from the mid-rib a single nerve ascends into each lobe, which rapidly spreads furcately. The number of nervures which reach the margin varies not only with the position of the pinnule on the frond, but also with the position of the lobe on the pinnule; in the pinnules towards base of frond the basal-lobe usually has 7 or 8 nervures, which in branching reach the margin. These gradually diminish in number towards terminal of pinnule, where usually only three or four nervures reach the margin, A similar diminution in the number of nervures reaching margin occurs in even the basal lobe of pinnules accordingly as we ascend the several pinnæ to the apex of frond.

I have described this handsome fern very minutely, especially as regards the number of lobes and nervures, as a number of species of this genus in Australia and Tasmania have already been described and recognised as distinct species upon small fragments of detached pinnules only, whose specific separation from each other is only based upon such small differences as occur together in different parts of the frond of the more perfect specimen now described by me as *S. Morrisiana.*

The first species so described by the late Professor John Morris (*S. lobata*) may well be included under the specific name covering a more complete specific description as now given; and possibly also the following species:—*S. flexuosa*, *S. hastata*, *S. germana*, *S. plumosa*, originally described by Professor Sir Fred. M'Coy from isolated pinnule fragments, may yet be referred to the more complete type. I have thought it best, in order to avoid confusion with the older specific names, to associate the form described and figured by me with the name of the author of the first described fragment (S. lobata), viz., *Sphenopteris Morrisiana*, mihi.

Upper Mesozoic coal measure shales, Seymour, Tasmania.

Sphenopteris tasmanica. (Nov. sp. Figs. 10-13.)

Frond bi-pinnate, lanceolate, probably when complete 12-15 inches in length. *Stipe* generally erect, round, slender, undulating. *Pinnæ* opposite, numerous, closely placed, symmetrical, linear-lanceolate, falciform, tapering gently and curving upwards. There are about 15 pairs of pinnules on the larger pinnæ towards the middle of frond. *Pinnules* somewhat ovato-deltoid, opposite, decurrent, unsymmetrical, the upper base being extended into a small auricle, which slightly overlaps the lower and straighter cut-away base of succeeding pinnule; margins of pinnule simple; the uniformly auricled base of pinnules gives a winged appearance to the very slender thread-like stalks of pinnæ. *Nerves*, a single somewhat strongly marked flexuous nerve ascends from rhachis into each pinnule, branching dichotomously; generally two pairs of furcations reach margin on either side of pinnule, and one pair reaching the apex; but these branchings vary, both with the position of pinnule on pinnæ and on froud, the lower side of pinnule often having one or two nerves less than upon upper side. All these nervures are firm and well-defined.

Greatest breadth of frond, 3-3$\frac{1}{4}$ inches.
Greatest breadth of pinnæ, $\frac{1}{4}$-$\frac{5}{8}$ inch.
Greatest length of pinnule, $\frac{3}{16}$-$\frac{1}{4}$ inch.

This interesting fern was discovered by the writer several years ago in the upper coal measure shales (Mesozoic) at Lord's Hill, New Town, near Hobart. It is very distinct from any other species of this genus, and is extremely rare, as 1 have found no trace of it elsewhere throughout similar formations in Tasmania.

Pecopteris Buftoni. (Nov. sp. Fig. 3.)

Frond unknown. *Pinna* imparipinnate, lanceolate-ovate; pinnules or lobes simple, sub-ovate, with round or bluntish apices, curving gently upwards; the narrow rounded sinus between each lobe extends nearly to rhachis, forming thereby a continuous narrow wing to which each lobe or pinnule is attached by its whole breadth; margins thickened as if caused by the curvature of a continuous marginal sori; mid-rib conspicuous; secondary veins concealed in a somewhat coriaceous integument.

Although the fragment is very imperfect, the above characters will serve to identify it, as it is very markedly distinct from any other allied forms described as occurring in Australia or Tasmania.

Collected by the Rev. J. Bufton from the Mesozoic shales of Dunally.

PECOPTERIS CAUDATA. (R. M. Johnston. Fig. 4.)

Fig. 4 is now referred by me to the above species. At first, owing to the more delicate structure and apparently finer neuration, I was inclined to separate it from the above species under the name *Pecopteris tonsorius*, but as this small difference may be due to habitat or to the medium in which it is preserved, I have thought it better to refer it for the present to my original species (P. caudata). The figure given is presented in natural size.

Locality.—Altered shales near East Bay Neck, Tasman Peninsula, Tasmania.

Collected by the Rev. J. Bufton, Dunally.

Thinnfeldia Buftoni. (Nov. sp. Fig. 18.)

Frond pinnatifid (? bi-pinnate); pinnæ nearly opposite, lanceolate, stromboido-lanceolate, falcate, accuminate; margin simple; the lower pinnæ probably shorter, giving the frond a broadly lanciform appearance; the upper side of base more or less roundly constricted, nearly auricled; the lower side of base also more or less constricted, and almost decurrent, giving the rhachis a faintly winged appearance; texture very delicate; stalk, though somewhat broad, appears to be thin, flat, weak, and membranaceous, with a few fine longitudinal striæ. Nerves, comparatively few, arising freely from base, and ascending dichotomously, and laxly, at a high angle (nearly parallel) to margin, the central nerve reaching apex, being only a little more prominent than the free lateral series. All the nerves are extremely fine, and are almost completely immersed in the delicate *pachypteris*-like tissue.

Length of larger pinnæ, about 1½ inches; greatest breadth, about ¼ inch.

In form and general characteristics it comes very close to *Thinnfeldia indica*, Fstm., of the Indian Rajmahal Group. It differs from the latter, however, in having finer and more delicate nerves, and a more delicate texture. The nerves differ also in the manner in which the greater number spring freely from base instead of acutely arising mainly from central primary. The more or less parallel arrangement of the nerves also distinguishes the species from its allied Indian congener.

This interesting fern occurs in the Upper Mesozoic shales, Dunally, where it was collected by the Rev. J. Bufton, F.L.S. I have now great pleasure in associating its name with its accomplished discoverer.

Thinnfeldia polymorpha. (Nov. sp. Fig. 16.)

Frond bi-pinnate, dichotomous; pinnæ never dichotomous, distant, opposite, sub-opposite or alternate, extremely variable in form; generally linear-lanceolate, linear-ovate, and occasionally simply ovate; bases contracted and somewhat auricled; margins variously aud irregularly sinuous, lobate, or simple; in some the lobes are confined to the base with narrow caudate extremities; in others the lobes, shallow and more or less irregular, are continuous throughout, and in a few they are simple or rudimentary. Stalk thick, and strongly grooved with an obscure nerve-like wing on either margin; each lobe has an independent set of fine branching nerves similar in character and arrangement to those of *Thinnfeldia obtusifolia*, Mihi., to which this strikingly variable form has a close affinity in many respects. Were it not that nearly every specimen of this polymorphous fern is similarly variable in the shales of Dunally, and the uniformly dichotomous and regularly lobed form of *T. obtusifolia* is rarely to be found there, I should hesitate in separating it from some extreme forms of the latter, but in any case the distinctive name now applied will serve a useful purpose for reference independently of doubt as to its true organic alliance. Length of the larger pinnæ, about 2½ inches; greatest breadth towards base, $\frac{1}{4}$-$\frac{5}{16}$ inch.

Very common in Mesozoic shales near Dunally. Collected by the Rev. J. Bufton, F.L.S.

In my work on "The Geology of Tasmania" (Pt. xxvi., figs. 2, 6, and 20) I refer certain doubtful forms to *Pecopteris caudata*, Mihi. I am now inclined to refer them to the above species, viz., *T. polymorpha.*

Genus Cardiopteris. *Schimper.*

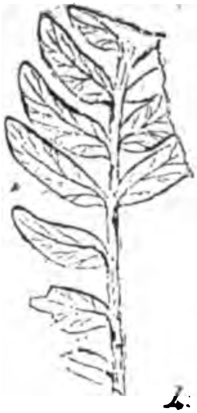
The following definition of the above genus is taken from M. B. Renault, Cours de Botanique Fossils (Fougeres, pp. 201-202):—

"Frond pinée, rachis strié longitudinalement, cylindrique, pinnilles insérées perpendiculairment à la face supériurede ce dernier, rapprochées, imbriquèes, ovales, cordiformes, plus pitetes à la partie infériure des pennes où elles prennent une forme circulaire; toutes ont une forme smyétrique, et sont inséprées par le milieu de leur base, coriaces, à bords infèctus, nervures égales naissant sur le rachis, plusieurs fois dichotomes, et sépanouissant en éventail."

Terrain Houiller. France.

8

6



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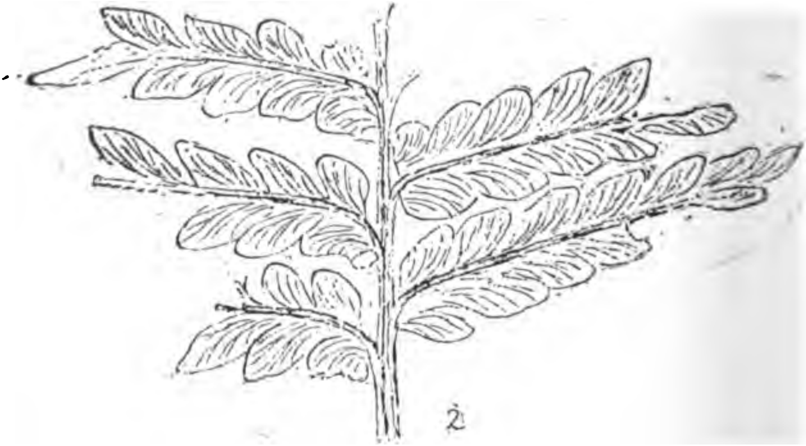

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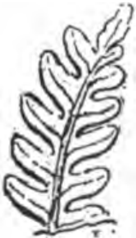

3

Cardiopteris tasmanicus. (Nov. sp. Fig. 9.)

Frond reniform-cordate, deeply auricled. Nerves numerous, distinct, although somewhat immersed in a coriaceous membrane, and radiating from base attachment to margin regularly, arcuately, and dichotomously.

With the exception that it is more symmetrically rotund and more deeply auricled, it comes close to *Cardiopteris frondosa* (Goe p.), Schimper.

Greatest length, $\frac{14}{16}$ inch. Greatest breadth, $\frac{14}{16}$ inch.

Locality.—Altered Upper Mesozoic coal measure shales, near East Bay Neck, Tasman Peninsula, Tasmania.

Collected by the Rev. J. Bufton, Dunally.

OTHER SPECIES OF PLANTS OCCURRING IN THE DUNALLY SHALES.

The greater part of the shales forwarded to me by the Rev. J. Bufton are much broken and friable, and the impressions are either obscure or very fragmentary. From a careful examination of these, however, I have, in addition to the forms already described, considerable confidence in referring a number of them to the following genera and species:—

Macrotæniopteris wianamattæ? Fstm.
Gleichenia dubia. Fstm. (Fig, 17.)
Trichomanides spinifolium. T. Woods.
Neuropteris tasmaniensis? R. M. Johnston. (Fig. 1.)
Ptilophyllum oligoneurum. T. Woods.
Pterophyllum. Sp.

REFERENCE TO FIGURES OF PLANTS DESCRIBED IN THIS PAPER.

Fig. 1. Probably a variety of the variable *Neuropteris tasmaniensis.* (R. M. Johnston.)
„ 2. *Thinnfeldia Feistenantelli.* (R. M. Johnston.)
„ 3. *Pecopteris Buftoni.* (Nov. sp.)
„ 4. *Pecopteris caudata.* (R. M. Johnston.)
„ 5, 6, 7. *Strzeleckia gangamopteroides.* (Nov. sp.)
„ 8. *Strzeleckia tenuifolia.* (Nov. sp.)
„ 9. *Cardiopteris tasmanica.* (Nov. sp.)
„ 10, 12. *Sphenopteris tasmanica.* (Nov. sp.)
„ 11, 13. Enlarged pinnules of 10-12.
„ 14. *Sphenopteris Morrisiana.* (Nov. sp.)
„ 15. Enlarged pinnules of 14.
„ 16. *Thinnfeldia polymorpha.* (Nov. sp.)
„ 18. *Thinnfeldia Buftoni.* (Nov. sp.)
„ 17. *Gleichenia dubia.* (Fstm.)

BOTANY OF THE HARTZ AND ADAMSON RANGES.

BY L. RODWAY.

(Read May 20th, 1895.*)*

The south-west of Tasmania has many attractions to the botanist, the principal of which are, firstly, that the district has not been examined botanically beyond a few flying visits to a few places; secondly, that there are many plants growing in this district that are seldom or never found elsewhere.

It is only my intention to refer to plants of unusual interest, whether of distribution or other detail, and in doing so I shall deal with them in the order they occur in Bentham's Flora Australiensis.

Eriostemon oldfieldii, F. v. M., occurs on a northern spur of Adamson's Peak. It has hitherto been only recorded from Mount La Perouse and Cradle Mountain, where it was obtained in young fruit only. I am now in a position to describe the flower. Sepals about ⅓ line long, broad; petals white and pink, narrow, oblong, about 2½ to 3 lines long; both sepals and petals vary in number from 5 to 7, but are generally 6; stamens usually 12, filaments long, slender, glabrous; style slender; cocci verrucose. Flowering about December.

Eucryphia billardieri, Spack, abounds throughout the district, ascending to nearly 4,000ft. At high altitudes the habit is a small shrub, and in places even procumbent and creeping over rocks, the leaves being reduced to ¼in. Hooker, in the Flora Tasmaniæ, describes the smaller leaved as a distinct species, *E. milligani.* In this district the transition is unbroken.

Anodopetalum biglandulosum, Cunn., is very abundant.

Drosera arcturi, Hook, is found everywhere at a high altitude, and *D. binata,* Lab., is common at the foot of Adamson's.

Leptospermum lanigerum, Sm., departs greatly from the type on the plateau of Adamson's, being nearly glabrous, with large leaves and flowers. A nearly allied form occurs in N.W. Tasmania and probably elsewhere.

Eucalyptus vernicosa, H., occurs on the Hartz, and here appears to constantly bear but one flower in an axil ; specimens from other localities are usually 3-flowered.

Geum renifolium, F. v. M., grows in the crevices of the rocks on the Calf at the back of Adamson's, as well as on the main ridge.

Diplaspis hydrocotyle, H., in swampy land on the plateau on the eastern side of the summit of Adamson's.

Actinotus suffocata, H., is widely distributed throughout the range, but I did not meet with the coarser *A. bellidioides*, H., which is the much commoner form towards the West Coast.

Actinotus moorei, F. v. M. et R., grows in quantity in a button-grass swamp on the track to the Hartz at about 1,700ft.

Aciphylla procumbens, F. v. M., hitherto only recorded from Mount La Perouse, grows both on the Hartz and Adamson's. This plant, though agreeing with *Aciphylla* in general habit, differs in the structure of the fruit in this feature approaching *Ligusticum*. Von Müeller proposed to suppress the genus and include it in *Gingidium*.

Comprosma moorei, F. v. M. et R., occurs on Adamson's.

Abrotanella scapigera, F. v. M., grows on the northern spur of Adamson's, near the Calf, but *A. forsterioides*, H., appears to be quite absent, its place being taken by *Donatia novæzelandiesæ.*

Helichrysum milligani, H., is very common on Adamson's, and the more common *H. pumilum* also occurs but sparingly.

Pterygopappus lawrencei, H., I observed in one small patch at the back of the Calf.

Senecio papillosus, F. v. M. Also only recorded from Mount La Perouse, is very common on Adamson's, but it did not appear to extend to the Hartz. The more scarce *S. primulifolius*, F. v. M., which occurs on La Perouse, I looked for in vain.

Senecio pectinatus, D. C., in divers forms occurs throughout the district. The type plant, var. *ochroleuca*, and var. *pleiocephalus*, also known as *S. leptocarpus*, D.C., grow all together with many intermediate forms.

Donatia novæzelandiæ, H., whose dense green cushions are exactly like *Abrotanella forsterioides*, H., so common on Mount Wellington, is very abundant throughout these ranges. This plant has a much wider Tasmanian distribution than has hitherto been recorded. It extends from Cradle Mountain to La Perouse, and from the Hartz to Mount Reid.

Archeria serpillifolia, H., appears at the back of the Calf.

Trochocarpa disticha, Spreng., *T. gunnii.*, F. v. M., and *Prionotes cerinthoides*, are very abundant.

Richea pandanifolia, H., is also very abundant, and *R. milligani*, F. v. M., occurs in quantity in the dip between Hartz and Adamson's.

Dracophyllum milligani, H., is tolerably common at the back of the Calf. By some mistake Bentham records this as attaining the height of *Richea pandanifolia*, and the Rev. Spicer, in his handbook, refers to the plant being erect, and 3 to 40 feet high. The habit of the plant is creeping, subterranean, sending up flowering branches that reach a height of 1 to 4 feet.

Cenarrhenes nitida, Lab., and *Agastachys odorata*, R. Br., are very common.

Arthrotaxis selaginoides, Don., occurs sparingly on the Hartz and the northern spur of Adamson's; but in the latter locality there are very many old dead stems, the remains of a forest that was destroyed many a long year ago. The oldest inhabitant says it was due to an extraordinarily hard winter.

Microcachrys tetragona, H., *Podocarpus alpina*, R. Br., and *Phyllocladus rhomboidalis*, Rich., are the only other conifers observed.

Milligania densiflora, H., is very common, and nearly replaces the more widely distributed *Astelia alpina*, R. Br.

Milligania stylosa, F. v. M., occurs on the eastern side of Adamson's. The perianth segments are quite 4 to 5 lines long. In the original description they are recorded as about 2 lines.

Juncus capillaceus, Hook, forms dense patches.

Centrolepis monogyna, Hook, also is most abundant, at least on Adamson's.

Gaimardia fitzgeraldi, F. v. M. et R., which has hitherto only been found sparingly on Mount Geikie by W. Fitzgerald, F.R.G.S., I found in great abundance in the dip between Hartz and Adamson's, and on the plateau to the east near the summit of Adamson's.

Ehrharta (Diplax) Tasmaniæ, F. v. M., is very common from the foot to the summit of Adamson's. I also found an *Ehrharta*, probably new to science, on the northern spur. I hope to shortly describe it.

Lomaria vulcanica, Blume, occurs on the Hartz.

Hymenophyllum malingii also occurs on the Hartz on the bark of *Arthrotoxis selaginoides*.

Cyathea cunninghami occurs between Esperance and Adamson's. This interesting fern has hitherto been recorded in Tasmania from Circular Head, near Scottsdale, Port Cygnet, Long Bay, Geeveston, and Oyster Cove. In Spicer's Handbook *Alsophila cooperi* is recorded from Adamson's. I am very disposed to think it an error; probably a barren frond of *Cyathea* is responsible for it.

Pleurophascum grandiglobum, *Splachnum (Tetraplodon) tasmanicum* also grow on Adamson's.

Forstera bellidifolia, Hook, grows throughout both ranges. Its place in this list should have been next *Donatia*. This interesting little plant has hitherto been found only on the western mountains of Tasmania.

NOTE ON TIMBER FOUND BENEATH ALLUVIAL DRIFT AT SWANSEA.

By Col. W. V. Legge, R.A., F.Z.S., M.B.O.U.

(*Read August 10th*, 1895.)

On the pleasant drive from Bicheno to Swansea the traveller, after crossing over the spurs of the range called "Lyne's Sugar Loaf" by the so-called "cut," comes suddenly in view of the large level tract of country lying south of the hills he is descending, and stretching from the hamlet of Cranbrook inwards towards the foot of the ranges which bound the St. Paul's Valley on the east. This tract is mainly formed by the coast range, which fringes the shore from St. Patrick's Head to Bicheno, suddenly swerving inland at the latter place, and joining the above-mentioned highlands east of the St. Paul's which lie at some distance from the East Coast. At the latitude of Swansea the ranges approach the coast again, and then follow the shore southwards. The level tract of country hemmed in by these features is alluvial, and forms what may be generally styled the basin of the Swan River, and its smaller companion streams, the "Cygnet" and the "Wye." Unfortunately the topography of this island is so poorly delineated on existing maps that the mountain features I have touched upon scarcely appear upon them, and unless one visits the district one would have no idea that there is so large a tract of level country on the Swan River.

The surface of this "basin" is mostly level, with here and there gentle rises of about 100 feet in altitude. The soil is chiefly dark chocolate, being apparently the result of denudation and drift from the extensive valleys on the highlands at the back. On the estate of Cambria, which lies mainly at the foot of the hill, locally called the "Lookout," the soil is rich and of great depth; and on that part of it lying between the main road and the shores of Oyster Bay there is a lagoon of considerable extent, which seems in former times to have had egress to the Meredith River by a watercourse now extinct, but visible in the form of an ordinary sinuous depression in the paddocks. Following the course of this depression a deep dyke has recently been cut by Mr. Meredith to drain the lagoon. In the shallowest part of the old watercourse this ditch attains a maximum depth of about 12 feet, and it was at the bottom of it that the men employed in the work came upon the log, lying transversely to the direction of the drain. It was so hard that they had considerable difficulty in cutting it asunder with an axe, a fact which may easily be realised on inspecting the sample of wood which accompanies this note. It will be observed that the wood is almost black, like the Irish "bog oak," and exactly resembles in texture a solid piece of ebony. When cutting it with the saw, the dust was exceedingly fine, somewhat like that obtained when sawing through a piece of bone. Judging from the appearance of the outer surface of the portions of the log examined by me, the wood is probably that of one of the *Eucàlypti*, and if so, it throws an interesting light on the antiquity of this genus of trees, as this example must have been buried many thousands of years. At the spot where the log was met with, the first three or four feet consisted of chocolate soil, which merged into a yellowish clay loam, darkening again at the depth of about 10 feet into a peaty substance. Further up the dyke, however, a thick bed of shingle, intermingled with stones of rounded form about as large as a man's head took the place of this clay; this was probably the bed of the stream, while the bottom of it, where the log became embedded, was no doubt muddy. Higher up, towards the lagoon, and where the depression caused by the old watercourse deepens, and the dyke is consequently shallower, the material excavated is dark peaty soil, which is continued to the edge of the morass. From the whole appearance of the surrounding land the alluvial deposit in question is one of great age, and renders the discovery of this timber at such a depth, and in such a hardened form, of great interest, not only on account of its antiquity, but in connection with the capability of the particular species of tree to withstand decay throughout such a lengthened period.

I append an ideal section of the land lying between the hill called the "Lookout" and the shore of Oyster Bay, showing the position of the dyke, and likewise a section of the dyke itself.

ON THE OCCURRENCE OF THE FANTAILED CUCKOO (*CUCULUS FLABELLIFORMIS*) IN TASMANIA.

By Col. W. V. Legge, R.A., F.Z.S., M.B.O.U.

(*Read August 10th*, 1895.)

On the 26th ult. (June), while driving to Swansea with Mr. Wragge, a beautiful adult example of *Cuculus flabelliformis* (Fantailed cuckoo) flew across the road near Apsley. The tract of country being passed through was mixed gum, she-oak (*Casuarina*), and Oyster Bay pine bush, and the cuckoo lodged on a branch by the side of the road, affording us a good view of its plumage. Such a late occurrence of this migrant is worthy of record; it is not probable that it would winter here, for it is noteworthy that several of our summer visitants have been observed in this sheltered region late on into the winter, and the cuckoo that we saw was probably allured into a prolonged sojourn on the East Coast by the mildness of the climate. *Cuculus flabelliformis* (Lath.) is an inhabitant of most parts of the continent, ranging from Cape York to Victoria, and thence westward to West Australia, extending far inland beyond the Murray. It usually arrives in this country at the end of September or beginning of July, and departs again at the end of March and throughout the month of April. I may mention here that Mr. O. Adams, one of our surveyors, saw an example in 1887, at the Piper River, on the 24th July. Whether or not this was an immature bird I am unable to say; if so, there is no doubt that, like many *immature* migratory forms, it had remained behind in the country of its birth.

NOTES ON THE OCCURRENCE IN TASMANIA OF THE "SOUTHERN STONE PLOVER" (*ŒDICNEMUS GRALLARIUS*).

By Alexander Morton.

(*Read August 10th*, 1895.)

The first published list of the birds of Tasmania was printed in the Proceedings of the Royal Society in Vol. III., 1854, page 142, by the Rev. T. J. Ewing, of New Town. In that list Mr. Ewing gives the numbers as follows:—Families, 28. Genera, 114. Species, 169. In 1886 Proceedings, an interesting paper, by Colonel W. V. Legge, R.A., F.Z.S., is published, entitled "Systematic List of Tasmanian Birds." In this list Colonel Legge divided the birds into the following twelve orders: — Accipitres — The Hawks and Owls, Psittaci, Cockatoos and Parrots. Picariæ—The Cuckoos, Kingfishers, Swifts, Morepork, and Night Jar. Passeres — The Crows, Summer Bird, Thrush, Magpie, Butcher Bird, Thickheads, Flycatchers, Robins, Wrens, Honeyeaters, etc. Columbæ — The Pigeons. Gallinæ—The Quail. Fulicariæ—Native Hen, Coot, Rail, etc. Grallæ—The Snipe, Curlew, Plover, etc. Gaviæ—The Terns, Petrels, Albatross. Steganopodes—The Gannet, Cormorants, and Pelican. Anseres—The Swan and Ducks. Herodiones—The Herons. Pygopodes—The Grebes; and the order, Impennes, the Penguins, making 35 families, consisting of 186 species. Since the above was printed the following birds have been sent to the Museum, being hitherto unrecorded from Tasmania. I give them in the order as they reached me:—(1.) The Semi-palmated Goose, *Anseranas melanoleuca*, first specimen shot at the Lake River, near Cressy, June 20th, 1888. This fine bird, not quite as large as the Cape Barren goose, is found in large numbers inhabiting the swamps and lagoons of Australia. (2.) The Australian Drongo, one of the large flycatchers, *Chibia bracteata*, was shot on the East Coast in 1888. The Magpie Lark of the Colonists of New South Wales, *Grallina picata*, was secured at Stanley in the same year. During the month of May, 1892, a pair of beautiful ducks were shot at Cambridge. On examination they proved to be the Blue-billed Duck of Australia, *Erismatura australis*. Mr. North in his work, entitled "Nests and Eggs of Birds in Australia and Tasmania," page 346, writes:—"This bird is dispersed over the southern and western portions of the Continent of Australia." The latest addition to the avifauna of Tasmania are a pair of fine specimens of the Southern Stone Plover (*Œdicnemus grallarius*). Although this is the first time this splendid example of the family *Charadriadæ* has been recorded as having been found in Tasmania, it has a very wide distribution on the Continent of Australia, being found at Derby, North-West Australia; Cape York, Rockingham Bay; through New South Wales, Victoria, South, West, and South-West of Australia. The late Mr. John Gould, in his work "The Birds of Australia," writes:—"I should suppose that there is no country on the entire face of the globe, except, perhaps, the Antarctic land, that is not inhabited by some species of this family. From Arctic America, through the course of the Andes, to Cape Horn, species occur." He further states that these birds are allied on the one hand to the Bustards, and on the other hand to the Plovers, and is the largest species of its genus yet discovered, its body being nearly the size of that of a hen pheasant. The flesh is excellent eating. The habits of this species are similar to the one found in Ceylon, *Œdicnemus scolopax*, generally found frequenting sandy plains, crowns and sides of grassy hills, and flats between the mountain ridges particularly. Gould says those that are of a rough and stony character. It is generally met with in pairs, but is occasionally seen in small companies of from eight to ten or more. It is a very shy bird, and runs with great facility, and when not disposed to take wing squats on the ground by the side of a stone or a prostrate log of wood, and there remains so close as almost to admit of being trodden upon before it will rise. Colonel W. V. Legge, in his excellent work on "The Birds of Ceylon," writes of the Ceylon species as being much smaller than the Australian are, and speaks of the Ceylon bird as being excellent in eating. The two Tasmanian specimens proved to be females. The first specimen was kindly sent me through Mr. J. McCluskey, of Spring Bay, having been shot in that locality about last April. The other was obtained at Swansea on the 28th of last month, kindly sent to the Museum by Mr. Frank Morris. Both birds were very fat, and in good plumage, although both the same sex the measurements differed. The bird from Swansea gave the following measurements:—Total length with tail, 22·5; tail, 8; wing, 12; tarsus, 7·6; mid toe, 2·2; culmen, 2·2; bill from gape, 2·5. The Spring Bay bird:—Total length with tail, 20; tail, 8·3; wing, 12; tarsus, 5·4; mid toe, 2·1; culmen, 1·8; gape, 2·3. This addition will give the number of birds known to Tasmania as 191.

NOTES ON FURTHER PROOFS OF GLACIATION AT LOW LEVELS.

By T. B. Moore, F.R.G.S.

(Read 14th August, 1895.)

Before giving notes on my late observations on the above subject, I take the liberty to begin with an extract from a letter by Professor R. V. Lendenfeld, of the University Czernowitz, relative to my paper on the discovery of the first proofs of land glaciation in Tasmania. The views of so able an authority, who was the first to discover positive proofs of land glaciation in Australia, will, I am sure, be interesting to the Fellows of the Society.

Professor Lendenfeld says :—"Your map shows that in the Tasmanian hill country delineated the character of the country, lakes, etc., is exactly alike the character of the Niederen Tauern in Carinthia, Salzburg, and Styria, at an elevation of about 2,500 metres. It is very certain that there—in the Niederen Tauern at that elevation—there have been glaciers a relatively short time ago, and I would say that in the similar country in Tasmania glaciers must have been *very recently*, for otherwise the lakelets would have already been filled up with debris. The glaciation deducible from your map should, I think, be placed in a more recent period than the glaciation of the Australian Alps. As to the glacial evidence itself, anyone acquainted with the subject must agree that the character of the country depicted in your map is a *certain proof* of the past glaciation of Tasmania."

Now I will pass on to discoveries made within the last few months up to the first week in November, 1894, of further proof of land glaciation at low levels, in substantiation of my paper on this subject read before the Royal Society last August.

Upon examination of the banks of the King River, which flows into Macquarie Harbour between Pine Cove and the settled portion of the town of Strahan, I discovered large ice-worn boulders striated and grooved in the deep gorge of the river situated at the Upper Landing ; also similar glaciated boulders in Harvey's Creek at a distance of a quarter of a mile from its junction with the King River at the Landing.

The boulders are large, many tons in weight, and are composed principally of Silurian sandstone. The planed surfaces, grooves, and striæ are fairly distinct, proving beyond doubt that as the ice marks are not obliterated in so friable a rock that the period of their transposition by ice is of a very recent date. As there are conclusive proofs that the whole mountain chain comprising the West Coast Range has been covered with a vast sheet of ice, we must conclude that rivers of ice have flowed down the damp, sunless, slate gorges of the King River, collecting as they went masses of sandstone from the surrounding heights, leaving them at a altitude of not more than 100ft. above sea level in their present shape and position at the Upper Landing and Harvey's Creek, distant about four to five miles from the range.

In the same locality, on the southern bank of the river, 150ft. above its bed, a large moraine occurs, composed of rocks brought from the inland mountains. Here we find mica slates, large boulders of greenstone, and many other formations not met with in the country west of the coast range. These boulders and pebbles are embedded in a clay or slaty matrix, and have been brought down the river gorge, probably at the beginning of our glacial period, before the erosion of the present bed of the stream.

During the recent substantial improvements to the Strahan-Lyell highway, a very interesting phenomenon of our glacial action has been exposed, through the accumulation of rubbish and moss being removed from the cuttings and drains of the road. As this phenomenon is so accessible on the way to the greatest mine in the island, which many scientists and geologists are sure to visit, it is to be hoped that more able men than myself will give views as to its age, origin, and nature.

A moraine commences about one mile from Strahan, and extends along the road towards Mount Lyell for a mile and three-quarters in width. A portion of the moraine near the surface is composed of yellow clay containing a few embedded pebbles; this rests on a recently formed conglomerate, with a binding of the same coloured matter, in other parts the yellow colour gives place to a conglomeration of pebbles in a blue slaty or clayey nature.

The texture of the binding material or "till" is fine and of rock-like hardness. It contains pebbles of all sizes, from mere atoms up to boulders a foot in diameter; the stones are either rounded, grooved, or planed, and many are covered with scratches and scored in various cross directions. All are of local origin, as no rock foreign to the West Coast can be found. Sheared pebbles of conglomerate and quartzite, similar to those found by Mr. E. J. Dunn, F.G.S., and myself in and derived from the Devonian conglomerate round Mounts Tyndall and Sedgwick are embedded in the moraine matter.

At two and a half miles from Strahan, in a cutting of the road a quarter of a mile from where the "till" is last traceable, the best section of the country can be seen. Here an outcrop of the bed rock for the first and only time in the "till" is observed, a blue slate lying at an angle of 80 degs., slightly distorted, but similar in character to the binding material of the glacial conglomerate. At this point we find an illustration of a "giant's kettle," a wide crevasse in the rock filled with "till," the outer wall being at the termination of the deposit. The excavation of the cutting is not sufficiently deep to show the whole depth of the filled-up crevasse, nor to allow me to give an estimate of the probable depth of the whole formation.

During former explorations of the country I found the deposit two miles further distant, in a north-east direction on Gould's old track of nearly forty years ago, re-opened in 1883 by the Meredith Brothers. Taking this and other enumerated facts into consideration, I arrive at the conclusion that the tend of the glaciers have been from the north-east, possibly from the highlands of Tyndall and Sedgwick, which are in that direction, and that the deposit is a moraine profonde, and if not precisely similar to the boulder "till" of the more ancient glacial epochs of other countries, it is the till of a more recent glacial period in ours. The moraines on the edge of Kelly's Basin, spoken of in a previous paper, are similar in character to the one just described, with the exception that as far as I have observed the pebbles are all embedded in a yellow clay.

The recent conglomerate or till on the Strahan-Lyell road is at an altitude of 150ft. to 200ft. above sea level. It is in no way identical with the ancient permo-carboniferous glacial conglomerate found by Mr. Dunn near Mount Read, nor with those referred to in my former paper on West Coast Glaciation as occurring at Mount Sedgwick and near Zeehan. The recent find is composed of rocks belonging to the district, principally slates, dioride, conglomerate, and quartzite, which are embedded in a matrix derived from the wearing down and grinding action of the ice over the local slate rocks, the general formation found in the lower lands of this territory.

The ancient conglomerate contains not only pebbles but large sized boulders quite foreign to the country; it is more consolidated, also of a much harder character, and the binding material is of a gritty sedimentary nature, showing that the deposits were formed under water and have a different age and origin.

After the discovery of the Kelly's Basin moraines and the huge ice-marked boulders in the vicinity of Farm Cove, I was convinced that our glaciers had in some instances descended to sea level, and since the finding of further proofs in the low levels at a considerable distance (18 to 40 miles) from the highlands, the most sceptical must now allow that the descent of these to sea level has been general.

Let us now consider the evidence we have regarding the age of our glaciation. Professor R. V. Lendenfeld's deductions are, that the glaciation of the Tyndall and Sedgwick country appears to belong to a more recent period than the glaciation of the Australian Alps. If this is allowed we have two glacial epochs in Australasia, or one long continuous period besides the ice age of the Permo-carboniferous era. In Western Tasmania our land glacial action has not been earlier than the Pliocene period, or we should find some evidences in the palæogene deposits round the shores of Macquarie Harbour, especially in the region of the ice-marked and worn boulders near Farm Cove. Let us assume that the glacial action in the highlands is of a more recent date than that of the deposits lately described, accounted for in this way: that the refrigeration of the climate was more intense at the commencement and middle of our glacial epoch than towards its close. During the intense period the ice has not wholly covered the land, but has extended far down into the low-lying valleys, and glaciers have descended even to sea level, or in cases nearly so, as proved by the moraines at Kelly's Basin, Farm Cove, King River, and Strahan. Towards the end of our glacial epoch the climate has become milder and the ice has retired from the lower valleys, still leaving a vast sheet on the highlands, which by subsequent local flows caused the more recent striations, etc., on the bed rocks, and on melting left the extensive moraines in close proximity to the mountain peaks.

The Australian Alps being further from Antarctic influence in a warmer latitude than our West Coast, possibly the refrigeration of the climate there has not been so intense. For, according to Professor Lendenfeld and other authorities, the glaciers have been local, being confined to mountains higher than our own, and the rocks now show less marked signs of ice influence than those in our islands. This would point to the fact that the age of glacial action in the Australian Alps may correspond with the more intense period of our glacial era, for assuming that the climate on the continent was milder, the ice sheets would therefore be confined to the higher mountains, and would probably have melted when our rivers of ice and glaciers disappeared from the lowlands. After the disappearance of all ice from Australia, the highlands of Western Tasmania would still be covered, causing the recent glaciation at the close of our glacial epoch.

Perhaps by some I may be considered an infatuated enthusiast, who has recorded actual facts of observation carefully; granted this is correct, still it is only by actual observation and the discovery of fresh proofs of glacial phenomena, that the age and intensity of our Glacial Period will be determined.

Trusting my recent discoveries may throw more light on so interesting a subject, and that some eminent authority, not too biassed by past theories, may examine them and give his views, either negatively or in concurrence with my statements, as to the existence of boulder till in the lowlands of the West Coast of Tasmania.

Illustrative specimens forwarded for the Tasmanian Museum from boulder till, Strahan, Lyell-road, viz.:—

No. 1, 2, 3, 4, 5 } A series of coloured conglomerates.

6 Binding materials of conglomerate.

7 Scored pebbles from above conglomerate.

8 Sheard Devonian pebbles from ditto.

THE PRIMARY LAW OF VALUE OR PRICE.

CONTENTS.

1. Introductory Remarks
2. How does the Germ of Economic Price or Value Arise?
3. Qualifications to be Admitted
4. The Law of Rent
5. The Law of Wages
6. The Laws of Surplus Profit of Manufacturer
7. The Ratio of Demand and Supply not the Primary Law of Economic Price
8. Permanence of the Ratios of Equivalent Exchange, Weights of Principal Commodities in Relation to Gold, and also to each other
9. The True Law of Value or Economic Price-orbits; correspond with Equivalent Exchange Weights
10. The True Cause of the Recent General Decline of Prices
11. Decline of Prices not due to *absolute* appreciation of Gold
12. Concluding Remarks, involving the Theory of Bimetalism

THE PRIMARY LAW OF VALUE OR PRICE.

REASONS BASED UPON STATISTICAL DATA SHOWING THAT ECONOMIC COST OF PRODUCTION—NOT THE RATIO OF DEMAND AND SUPPLY—IS THE PRIMARY LAW WHICH REGULATES AND DETERMINES THE RESPECTIVE RATIOS AND PRICES AT WHICH THE PRECIOUS METALS AND ALL OTHER COMMODITIES AND SERVICES EXCHANGE WITH EACH OTHER.

BY R. M. JOHNSTON, F.L.S.

(TABLES AND DIAGRAMS.)

Read September 9th, 1895.

INTRODUCTORY.

No field of inquiry has suffered so much from the lack of uniformity, precision, and proper classification and definition of terms as that branch of art or science which relates to Social Economics. Perhaps these imperfections were unavoidable in the early stages of investigation of matters so complex and variable, and may have been perpetuated by the idea that the popular appreciation of important Social and Economic questions might be aided by the retention of words in common use. The terms Capital, Utility, Wealth, Value, Price, Rent, Profit, Wages Fund, Wages, Interest, Demand, Supply, Cost of Production are of this class, and are still frequently a source of confusion because of the very different meanings which different writers loosely attach to them. Professor Marshall and Gunton, among modern Economists, have done good service in giving greater precision to our language when making use of such generic words, by the adoption of requisite qualifying terms, denoting the specific sense in which the original, or root, term is to be understood.

The terms thus adding greater precision to Economic language are now becoming better understood, and prevent much of the confusion in discussion which formerly was almost unavoidable. The following is a list of the more important of these specific terms now in constant use among Economic students:—

WEALTH.—*Wealth in Exchange, or Exchange Wealth, Social Wealth, National Wealth, Cosmopolitan Wealth, Capital Wealth, Consumable Wealth.*

CAPITAL.—*Individual Capital, Trade Capital, Social Capital, Consumption Capital, Auxiliary Capital, Potential Capital, Circulating Capital, Fixed Capital, Personal Capital.*

Utility.—*Total Utility, Marginal or Final Utility.*

Value.—*Price, Exchange Value, Money Value, Unit of Value, or Ratio or Measure of Exchange, Economic Price, Present Value, Deferred Value, Capital Value, Annual Value.*

Rent.—*Ground Rent, Building Rent, Producer's Rent, Ability Rent, Wages-earner's Rent, Economic Rent, Quasi-Rent.*

Price.—*Economic Price, Equilibrium Price, Monopoly Price, Esau Price, Fancy Price, Famine Price, Robbery or Violence Price, the Price of Honour or Virtue, Final Margin of Purchasing Price.*

Wages.—*Nominal or Money Wages, Real Wages, or Purchasing Power.*

The greater precision which the use of these specific terms, as defined by Economists, affords in discussion is invaluable, and has been the means of clearing up many difficulties.

Notwithstanding the advantages which improved nomenclature have gained for us, there are several important questions regarding which there still exists many conflicting opinions. One of these questions, upon which many controversies hang, is "The Primary Law which regulates and determines the ratios which Economic Commodities and Services exchange with each other;" in other words, "The Primary Law of Price or Value." This is the subject which I have selected for my discourse this evening, and although in the short space which I have at my disposal I can only touch upon the leading features of the question, I hope, by the aid of statistical data and other illustrations, to demonstrate the truth of the assertion which I have ventured to make at the beginning of this paper, viz., "that economic cost of production—not the illusive and indefinite something called the ratio of demand and supply—is the primary law which regulates and determines the respective ratios and prices at which the precious metals and all other commodities and services exchange with each other."

But first it may be useful to inquire :

How Does the Germ of Economic Price or Value Arise ?

At this stage we may with advantage postpone the consideration of the causes which determine the exact exchange ratios or prices of services and commodities, and confine our attention to the investigation of the origin of the initial element of price or value *per se*, irrespective of amount or ratio.

Although Ricardo and Adam Smith did not at first sufficiently qualify their observations to avoid adverse criticism, it is now manifest that their ideas regarding the origin of price and equivalence of exchange require very little modification to be accepted as true by the most advanced economic thinkers of the present day. If we simply substitute "*cost of man's services*," which embraces quality and effectiveness of labour, in place of their original expression "*quantity of labour*," even Gunton, the most recent of thorough exponents of the true origin of the "Primary Law of Price," would give assent to Ricardo's original statement regarding "the equivalence of exchange value," or, as he (Ricardo) states it, "the rule which determines how much of one (commodity) shall be given for another depends almost exclusively on the comparative *quantity of labour* expended on each." Substitute cost of man's service "for *quantity of labour*," and we have the true explanation of the origin of economic price or the "primary law which regulates and determines the respective ratios and prices at which . . . commodities and services exchange with each other."

Ricardo very clearly and succinctly establishes this fundamental truth as to the origin of value and ratio of exchange in his Principles of Political Economy (chap. i. pp. 9, 10. M'Culloch's new edition of "The Works of David Ricardo," 1888) in the following statement:—

"There are some commodities, the value of which is determined by their scarcity alone. No labour can increase the quantity of such goods, and therefore their value cannot be lowered by an increased supply. Some rare pictures, scarce books and coins, wines of a peculiar quality, which can be made only from grapes grown on a particular soil of which there is a very limited quantity, are all of this description. Their value [a] is wholly independent of the quantity of labour originally necessary to produce them, and varies with the varying wealth and inclination of those who are desirous to possess them."

"These commodities, however, form a very small part of the mass of commodities daily exchanged in the market. By far the greatest part of these goods (*fully* 99 *per cent.*) which are the objects of desire are procured by labour; and they may be multiplied, not in one country alone, but in many, almost without any assignable limit, if we are disposed to bestow the labour necessary to obtain them."

"In speaking, then, of commodities, of their exchangeable value, and of the laws which regulate their relative prices, [b] *We mean always such commodities only as can be increased in*

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[a] *Fancy Price*, as distinguished from *Economic Price*.

[b] Fully 99 per cent. of all commodities in exchange fall within this definition, and are governed by the Primary Law which determines *Economic Price*.

quantity by the exertion of human industry, and on the production (and supply) *of which competition operates without restraint.*"[a]

Ricardo having thus clearly defined the particular domain in which the Primary Economic Law of Price operates, and to which all illustrations which relate to Value and Price should be strictly confined,[b] proceeds to disclose the entry of the basal element of all value and price, which, when incorporated in any material substance by means of detached claim or title, such as money wages or other recognised medium of claim, is thereafter indissolubly united with it as the almost sole measure of its Exchange Value. This basal element of value he discovers in "the comparative quantity (cost?) of labour expended on each" particular commodity, or in maintaining any particular kind of labour service.

Thus he goes on to observe:—"In the early stages of society the exchangeable value of commodities, or the rule which determines how much of one shall be given in exchange for another, depends almost exclusively on the comparative quantity (cost?) of labour expended on each."

The Elemental Ratio or Unit of Exchange.—Ricardo then proceeds to show, by a quotation from Adam Smith, which he accepts, that "The real price of everything, what everything really costs to the man who wants to acquire it, *is the toil and trouble of acquiring it.* What everything is really worth to the man who has acquired it, and who wants to dispose of it, or exchange it for something else, is the toil and trouble *which it can save to himself*, and which it can impose upon other people. . . . . Labour was the first price—the original purchase-money that was paid for all things." Again, "in that early and rude state of society which precedes both the accumulation of stock and the appropriation of land, the proportion between the quantities of labour necessary for acquiring different objects *seem to be the only circumstances which can afford any rule for exchanging them for one another.* If among a nation of hunters, for example, it usually cost twice the labour to kill a beaver which it does to kill a deer, one beaver should naturally exchange for or be worth two deer. It is natural that what is usually the produce of two days' or two hours' labour

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a. Where abnormal conditions come in, crippling the reasonable choice or freedom of one of the parties—a forced or absolutely necessary exchange—such as in the exchange of Esau's birthright for a mess of pottage—it might be convenient to define all such exchange value as The *Esau Price* or the *Final Margin of Purchasing Power.*

b. The confusion and opposition of Jevon's and other opponents to Ricardo's theory of "The Primary Law of Economic Price" is due largely to a failure on their part to confine their references and illustrations to the true domain in which the Primary Economic Law of Price operates, and to which Ricardo insisted that it should be confined.

should be worth double of what is usually the produce of one day's or one hour's labour."

In quoting Adam Smith's views, with full approval, Ricardo concludes:—"That this is really the foundation of the exchangeable value of all things, excepting those which cannot be increased by human industry, is a doctrine of the utmost importance in political economy; for from no source do so many errors and so much difference of opinion in that science proceed, as from the vague ideas which are attached to the word value."

The most important corollary to be drawn from such a doctrine is, that all natural elements and their compounds, which form the substance of commodities, whether rare as gold, silver, or tin; or common as coal, iron ore, salt, or water, are, of *themselves*, free gifts of nature, and do not form any part of Value or Economic Price. Man cannot create the elements of material substances, but by his forethought, intelligence, and labour, he can modify and transport, and can provide favourable conditions for the natural increase of specific forms of utility. The latter service of man and its extent merely constitute the *measure of the quality* we otherwise call *value or price* in the particular compounds of natural elements in which, by the laws of Social Economy, it has become so closely incorporated as to be confounded with some supposed intrinsic value in the natural substance *per se*.

The phrase "free gifts of nature" by most people is usually restricted to those things—like pure common air, rain, and sunshine, so necessary to man's life and comfort—which are obtained directly by natural means without the intervention of other men's services; but the acceptance of the doctrine of the Primary Law of Economic Price or Value leads us a step further, and compels us to concede that although all monopolised natural substances in which man's services are incorporated are inseparably associated with Economic Price or Value, the natural elements themselves do not enter into it in any degree whatever; and, therefore, the rarer natural element, *gold, per se,* adds as little to economic price or value as the more common elements, *carbon, hydrogen, oxygen, silica, sodium, chlorine, nitrogen,* etc., do to compounds of common substances, such as coal, common salt, grain, and other food products.

QUALIFICATIONS TO BE ADMITTED.

There are some objections which may be raised, here, against the doctrine that Cost of Production is the Primary Law of

Price, based upon the following considerations, which it may be profitable to discuss :—

First, it is admitted generally as an axiom in economics, that *in the same market there can only be one price for specific articles of the same quality.*

(1) Seeing that the same area of good land may yield A double the quantity of produce grown by B on poor land without any difference in the actual cost of production. How, in the face of "one price for the specific articles of the same quality," can this effect be reconciled with the doctrine that Cost of Production is the Law of Price?

(2) A similar objection applies to cotton cloth and other manufactures. A, *e.g.*, by the use of superior appliances, may produce four yards of similar cotton at the same cost as it would take B to produce three yards.

(3) Similarly in respect of cost of labour services: Two carpenters of equal skill working at the same bench receive the same daily wages. The maintenance of A with a family to support involves, perhaps, three times the cost of B, a single man, even with the same standard of living.

All these examples would have great force as bearing against the Primary Law of Price were it not that the word "Primary" does not exclude the conception of minor influences which qualify and modify to some extent the operation of the Primary Law. But even the examples given are perfectly reconcilable with the doctrine when stated more completely. For Cost of Production, *i.e.*, economic cost, ignores the variations of actual cost among different producers of the same class of articles as the individuals of the same class working under the greatest disadvantages are the sole determinants of the uniform market price of the common product.

Thus, as regards the price of agricultural products, the normal rate of wages for each class of occupation, as well as the price of manufactured products, are all alike really governed by the same economic law, namely, "*the cost of producing the most expensive portion of the supply necessary to satisfy the same market.*"

The difference of actual cost of production between those in the same occupation, who are working at a greater advantage and those at the greatest disadvantage, is absorbed by the former as an extra reward for services. In the case of Landowners it constitutes Economic Rent; in Manufacturing and other industries, and in Wage-earning Services it is termed Surplus Profit, or Quasi-Rent.

In none of these cases does the Economic Rent or Surplus Profit so absorbed add in any degree to Economic or Market Price, for the latter is solely determined by the respective representatives of the groups of the same class working under the greatest disadvantage; that is, at the no-rent or no-surplus-profit stage.

I am indebted to Gunton for the following tabular illustrations, which help to reveal more clearly how the marginal differences of cost of production between the same class of producers or workers are absorbed by the more fortunately circumstanced, in the shape of Economic Rent or Surplus Profit, and how the circumstances of the least favoured or "most expensive portion of supply" alone determine the market price.

The Law of Rent. (Gunton.)

"Under conditions of Economic Freedom the rent of land used for any purpose tends to equal the difference between its productive utility and that of the poorest land used for the same purpose in that community, or which contribute to the necessary supply of the same market."—Gunton.

Illustration.

RENT PER ACRE.	SURPLUS PER BUSHEL.	PRICE PER BUSHEL.	COST PER BUSHEL.	BUSHELS PER ACRE.	
Dollars.	Cents.	Dollars.			
6.00	25	1.	Minimum Cost ... 75 c.	24	D
4.00	18	1.	" " ... ... 82 c.	22	C
2.00	10	1.	" " ... ... 90 c.	20	B
0.00	00	1.	Maximum Cost ... ... 100 c.	18	A

The Law of Wages. (Gunton.)

"The law then may be correctly stated thus :—

"The rate of wages in any country, class, or industry constantly tends towards the cost of living of the (average of) most expensive families who furnish a necessary part of the supply of labour in that country, class, or industry."—Gunton.

ILLUSTRATION.

CENTS.	DOLLARS.	DOLLARS.		
0	2	Maximum Cost 2.00		A
5	2	" " 1.95		B
10	2	" " 1.90	SOURCE OF SAVINGS OR SURPLUS PROFIT.	C
15	2	" " 1.85		D
20	2	" " ... 1.80		E
25	2	Minimum Cost 1.75		F
SURPLUS PROFIT OR SAVINGS.	NOMINAL WAGES.	ACTUAL COST OF LIVING.	COST REDUCED BY CHEAP LIVING.	

THE LAW OF SURPLUS PROFIT OF MANUFACTURERS.

(*Gunton.*)

" While the dearest capitalist and the dearest labourer both fix the prices for their class, they both occupy relatively opposite positions. The manufacturers who furnish the most expensive portion of the supply of commodities are the poorest and lowest in their class, while the labourers who furnish the most expensive portion of labour-power are the best and highest in their class, as shown."—GUNTON.

ILLUSTRATION.

SURPLUS PROFIT.	PRICE.	ACTUAL COST (Cents).	COST SAVED BY CAPITAL.	
Cents.	Cents.			
1	4	Minimum Cost 3		F
$\frac{4}{5}$	4	" " ... $3\frac{1}{5}$	SOURCE OF PROFITS.	E
$\frac{3}{5}$	4	" " ... $3\frac{2}{5}$		D
$\frac{2}{5}$	4	" " ... ... $3\frac{3}{5}$		C
$\frac{1}{5}$	4	" " ... ... $3\frac{4}{5}$		B
0	4	Maximum Cost 4		A

The illustrations given are of value in giving greater precision to the doctrine of the Primary Law of Price, and helpful in freeing the mind from misconception in the further examination of the rival theory of the Law of Economic Prices, viz., the "Ratio of Demand and Supply." This theory, however fallacious, is plausible, and has the prestige of having been tacitly held or expressly advocated by a very large number of Economists, whose general qualifications are such as to entitle them, at least, to the most respectful consideration, even if their conclusions cannot command assent.

This rival theory claims that Economic Prices are mainly determined and regulated by the varying *Ratio of the Demand and Supply.*

More explicitly. This doctrine affirms[a]:—"(1). That under free competition (*i.e.*, in the absence of arbitrary barriers) there cannot be two prices for the same commodity in the same market"—a proposition common to both of the rival theories; and the same may be affirmed of the next, viz:—(2). That, when the supply and demand are equal, the price is the exact equivalent of the cost of production. The real and fundamental divergence between the rival theories is contained in the third proposition, viz.:—(3.) That the price rises as demand exceeds the supply, and falls as the supply exceeds the demand; and "the rise or fall continues until the demand and the supply are again equal to one another."

The Ratio of Demand and Supply not the Primary Law of Economic Prices.

If the claim that the ratio or relative intensity of Demand and Supply, respectively, is the major influence in determining the rise or fall of Economic Prices over a long course of years, it would need proof to sustain the two following propositions:—

(1) That prices in all cases rise in ratio or proportion as demand exceeds supply in intensity or magnitude, and that, conversely, prices in all cases fall in ratio or proportion as supply exceeds demand in intensity.

(2) That whenever the ratios or intensities over a number of years touch the equilibrium point, that is, are exactly equal, then the price of the particular commodity or service returns to a measure of value which, in itself, is constant and invariable under such conditions.

As regards the first of these postulates, it may be affirmed, with reason, that even if it seems to be true as regards short periods corresponding to the perturbation or fluctuation of

[a] Gunton.

seasonal or cosmical influences, it affords no explanation of a general and continuous fall of prices over a large number of years when conjoined with an ever-increasing *real demand.*

Wheat.—Take the commodity *wheat* for example. The absolute measure of the intensity of demand is most surely determined by the extent of its consumption, per head. In the United Kingdom, this intensity of real demand is indicated by the fact that the consumption in the year 1840 amounted to 255lb. per head per year, while its *price* per ton averaged £16·60. The absolute intensity of requirement or demand continued gradually to *increase* to such an extent that in the year 1887 it is indicated by a consumption of 354lb. per head of population, or an increase of intensity of *real demand* equal to 38·82 per cent., while its *price* did not *increase* in the *ratio of real demand*, but actually fell to £8·15 per ton, or a fall of as much as 50·90 per cent., that is, half the price, as compared with the earlier period when the real demand was much less intense.

Meat.—Again we have another anomaly, which, taken with the former instance, is equally unexplainable by what is termed the "scarcity of gold theory of decline of general prices, or by the Law the Ratio of Demand and Supply." Thus in the United Kingdom in the same year, 1840, the average consumption of meat was 87lb. per head, while its market price was £54·5 per ton. Both demand and price gradually increased, *but at very unequal ratios*, until the year 1887, when the average consumption rose to 109lb. per head, or 25·29 per cent. increase, and the market price rose slightly to £58·5, being an increase of only 7·35 per cent.

Average Wages of Agricultural Labour.—A still more remarkable example of inconsistency with either the "Scarcity of Gold" or the Ratio of Supply and Demand theories, and constituting indeed a complete inversion of their theoretical conclusions, is to be found in the United Kingdom, between the years 1840 and 1887, in respect of the rapid fall in demand for agricultural labour generally, associated with not only a gradual *increase* in agricultural labourers' nominal wages, but a still more decided increase in the purchasing power of the same wages.

Thus in 1840 there were 3,400,000 labourers employed in agriculture with average wages at 12s. per week. In 1887, notwithstanding an increase of 38 86 per cent. in the total population, the number of agricultural hands fell to 2,560,000, or a decline of 24·70 per cent., while their nominal wages rose to an average of 15s. per week, or 25 per cent. increase, and while also the real purchasing power *increased* fully 50 per cent.[a]

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a. See fuller particulars page 17.

PROGRESS OF COTTON INDUSTRY IN THE UNITED STATES Between the Years 1830 & 1880

PARTICULARS	1830	1880	Per Centage Increas or Decrease since	
			INCREASE	DECREASE
Establishments Nº	801	756		562
Capital Invested Dollars	40,612.984	208.280.346	412	
Ditto per Establishment ..	50,702	275.503	443	
Ditto per Hand .	653	1,202	85	
Persons employed Nº	62.208	172,544	177·4	
Spindles . ..	1,246.703	10,653,435	755	
Cloth produced lbs	59.514.926	607.264.241	920	
Ditto per Hand ..	950·7	3.519·5	276	
Ditto per Spindle ..	47·6	57	19·7	
Ditto per Dollar Capital .	1·4	2·4	71·4	
Spindles per $100 Dollar Capital Nº	30·7	51·2	66·8	
Ditto per Hand .	22	62	182	
Ditto per Establishment .				
Consumption of Cotton Cloth per head of Population lbs	5·30	13·81	134	
Price of Cotton Cloth per Yard cents	17	7		58·8
Operatives Wages per Week Dollars	2·55	5·40	112	
RELATIVE.				
Purchasing Power of Wages operative over the products of his own labour	15	77·1	414	

For further evidence against the two theories under trial, let us study the movements of an important manufacturing industry in another country (United States) in its development between the years 1850 and 1880, or an interval of 30 years, as in the following table, prepared from certain statistics relating to the Cotton industry of the United States, quoted by Gunton (p 263, Principles of Social Economics) :—

(Table A.)

In the accompanying table we have the true cause of the recent fall of prices of commodities most clearly and unmistakably demonstrated. In 50 years the causes at work produced:—

(1.) A fall in the price of cotton cloth of 58·8 per cent.

(2) A rise in the nominal wages of the operatives of 112 per cent.

(3.) An increase of the real wages or purchasing power of the operatives over the product of their own industry of as much as 414 per cent.

Among the more important causes which effected these splendid economic advantages are :—

(1.) The reduction in cost of management by the concentration of the work in fewer but larger and better equipped establishments.

(2.) Improvements in machinery and other auxiliary aids to human labour enabling one hand to control 62 spindles, whereas formerly one hand could control only 22 spindles.

(3.) The effective producing power of each worker by such means was increased 3 7 fold, or nearly four-fold. That means that the labour of producing 1lb. of cloth per hand was reduced 73 per cent.

(4.) The price of cloth was, however, reduced only 58·8 per cent., but the difference of 14·2 per cent. is accounted for by being absorbed by the increase of 112 per cent. in the nominal wages of the operatives.

The "scarcity of gold" theory of the decline of prices cannot be reconciled with these plain facts, for the decline of 58·8 per cent. in cotton cloth is conjoined with an increase of 112 per cent. in the wages of the operatives. The fall of 58·8 per cent. in prices is likewise irreconcilable with the Ratio of Demand and Supply theory, for this remarkable fall is associated with a growing intensity of real demand, the consumption of cotton cloth per head of population having gradually increased from 5·90lb. in the year 1830 to 13·81 in 1880, or an increase of 134 per cent. of real demand.

Cheapened cost of production—the true Primary Law of Economic Price—is the only theory which harmonises *with all the facts!* Theories like those already referred to (scarcity of gold or appreciation of gold, and Ratio of Demand and Supply), which can only at best be reconciled with a very small part of the facts, must be abandoned as unsatisfactory and altogether misleading. Indeed, when we look at the matter broadly and thoroughly, we must find conclusive evidence to show, in respect of commodities which can "be increased by the exertion of human industry," that supply is subordinate and depends upon demand. The breadth and intensity of the demand determines the breadth or intensity of the supply. The demand for commodities is the measure of the intensity of the need or desire to consume them. Gunton clearly puts it:—"To-day's wants determine to-morrow's efforts, and yesterday's actual consumption determines to-day's actual production. . . Since consumption constitutes the actual demand, and production the actual supply, it follows that demand is the cause (and measure) of the supply." And we might add that the cost of producing the supply is the Primary Law which determines its economic price.

Permanence of the Ratios or Equivalent Exchange Weights of Principal Commodities in Relation to Gold, and also to each other.

In civilised countries commodities of all kinds, by price lists, have their values equated to the established standard of value,—*gold*. In the United Kingdom the *sovereign* is the principal unit, and has been determined by law to consist of a specified weight (·25682 of an ounce, having $\frac{9166}{10000}$ purity) of the commodity gold, which is also used more extensively for other purposes than money. In general utility, and even in the magnitude of its value as an industrial product, gold is one of the most insignificant and almost the least valuable of all commodities which are requisite for man's use. Its utility is trifling as compared with wood, iron, or coal, and even though costly in relation to quantity or weight, its total value as one of the commodities produced annually by the principal civilised countries is as 19 to 12,507, or 0·15 per cent. of all industrial products.[a] In relation to the annual

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[a] See appended table showing value of different classes of industrial products

IC VALU

ODUCTS

B

Relative value of Products

of Various Industries of the Principa
Countries of the World.

1887-8	Mil £	Proportion per £
Manufactures	4.618 *	3,692
Agricultural & Pastoral	3.948 †	3.157
Commerce	2.827	2.260
Transport	864	691
Mining	250	200
	12.507	10.000

DETAILS		Proportion per £ 10.000
Manufactures	4.618	3,692
Commerce	2.827	2,260
Grain	1,091	872
Transport	864	691
Green Crops	859	687
Meat	608	486
Various agricultural Prod.s	543	434
Dairy	401	321
Garden	259	207
Wine	187	150
Coal	131^{2}	105
Various Minerals	52	42
Silver	19	15
Gold	19	15
Iron	15	12
Copper	6	5
Lead	3^{5}	2^{6}
Tin	2^{5}	2
Zinc	·1.8	1.4
	12.507	10.000

* Cotton industry £ 281 mil
† Wheat £ 543 mil:

(Table B.)

value of all human services it is still more insignificant, as it is estimated to bear the ratio to them of 19 to 19,334, or 0·098 per cent. Apart from its great utility in barter as a means of facilitating exchanges, and its qualities of indestructibleness and portability, its principal utility is that of a common measure of the value of all other commodities. It is the established handy foot-rule for measuring the value of all other commodities and services, but its own value bears no more comparison in magnitude to the commodities of which it is the standard measure than does the sixpenny foot-rule of the builder or architect to the value of the costly fabric whose various dimensions have been determined by the useful but cheap foot-rule. It is necessary to bear this in mind, because there exists a superstitious idea, widely held, that the real element of economic value incorporated in the substance of gold (*i.e.*, the cost of human services engaged in procuring it) differs in some mysterious way from precisely the same kind of real economic value incorporated in potatoes or any other common commodity.

The magnitude of economic value in any commodity is not determined by its size or weight, nor by its abundance or scarcity, but by the average economic cost, at any time, of the useful services of man absorbed in its production, transport, modification, etc., and thereafter incorporated in the particular substance or commodity in the same way that mortgage title upon a valuable property incorporates the value of mortgagee's money investment.

If it can be shown, therefore, that the ratios of equivalent exchange weights of different commodities with gold and with each other are identical with the ratios of men's time and services absorbed in producing them, the major contention of my argument will be established, viz.:—*That cost of Production—(not the Ratio of Supply and Demand, nor mere abundance or scarcity)—is the Primary Law which determines and regulates Economic Price.*

The usual manner in which different commodities are quoted in price lists, in relation to money value, makes it difficult to realise their relative values to each other. Thus one commodity has its money value expressed in relation to a definite bulk, such as barrel, bushel, gallon. Another to different units of weight, such as ounce, pound, cwt., ton; and the services of man, use of property, money, etc., are always related to a measure of time, such as per hour, day, week, month, or year. Commodities, however stated, can be resolved into one quality common to them all, viz., weight, by which they may be perfectly equated in the relation of the ratios of equivalent weights to unit of value, *i.e.*, to £1, or, what is the same thing, ·25682 of an ounce of ·916 pure gold. The following table has been constructed by me in this way, and embraces 28 of the principal commodities of English commerce, and representing the most important of all human industries.

(Table C.)

On examining the preceding table, the first thing that arrests attention is the great range of differences of the equivalent exchange weights of different commodities. Thus in 1893 1 ton of gold is shown as the equivalent of 22·23 tons silver; of 1,247 tons tin; of 1,344 tons copper; of 2,628 tons beef; of 7,158 tons sugar; of 7,520 tons lead; of 16,695 tons flour; of 136,000 tons salt; and of 348,636 tons of coal.

The most striking thing, however, shown in the figures relating to the two periods 1870 and 1893, is the permanence or persistency of their relative exchange weights with the central unit of their system—gold—and with each other.

Seeing that all the commodities (excepting their standard, which cannot of itself show variation) have been greatly affected by alteration of prices—some having risen by as much as 59 per cent. (salt), while the greater number of prices of commodities have fallen at various degrees from 4 to 46 per cent.—it is remarkable that the relative value-orbits—if we may coin a suitable phrase—only amount to an exhibition of greater or less eccentricity of orbit; and not (except in one or two instances where the values of commodities lie close to each other) to any disturbance of the original sequence in their order or weight distance from gold, or the centre of the system around which we may picture them as revolving as in the diagram which I have prepared to illustrate this very important law.

(Diagram I.)

THE TRUE LAW OF VALUE OR ECONOMIC PRICE ORBITS (CORRESPONDING WITH EQUIVALENT EXCHANGE WEIGHTS).

The true law of value or economic price orbits of various commodities relative to the centre of their system—the gold unit—have their equivalent exchange weight magnitudes primarily determined inversely in the exact ratio of their cost of production. That means that the greatness of the radial distance of the commodities from the central unit of value corresponds exactly with the corresponding smallness of cost of production relative to a common unit of weight. Thus the radius of the value-orbit of coal is very great as

Equi
# of Princip
1870 & 1893. Ba

YEAR	1
Commodity	
Gold	
Silver	
Cotton Yarn	
Wool	
Tea	
Tin	6
Butter	
Cotton	
Copper	
Tobacco	
Cheese	1
Pork	1
Coffee	1
Hams	1
Beef	1
Herrings	1
Sugar	1
Fish various	1
Lead	1
Flour wheaten	2
Wheat	2
Steel rails	2
Iron bars	23
Potatoes	24
Iron ore	25
Salt	26
Coal (pit mouth)	27
Water supply	28

*......Relative

†.......

$......Approxim

–......Indicat

+.......

NCE

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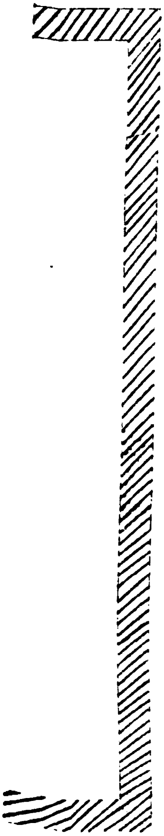
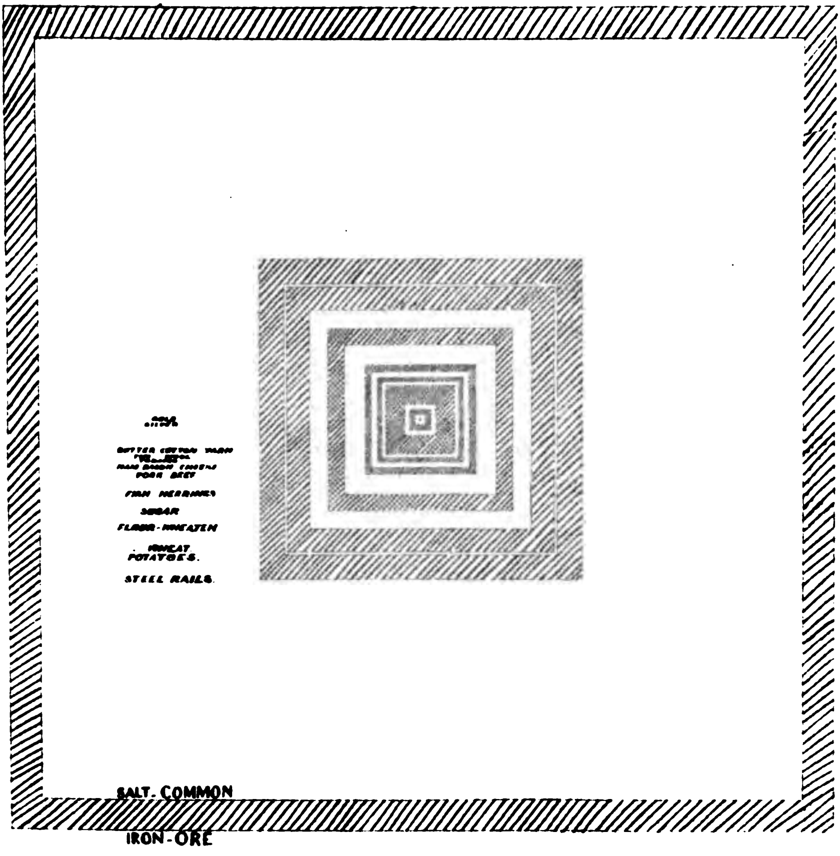


C A

WEIGHT EQUIVALENTS OF EXCHANGE
PER
STANDARD MONEY
UNIT ※

※ SOVEREIGN = 0.257 Oz: Gold of .916 degrees Fineness
= 0.00000035610 TONS GOLD



(P.13)

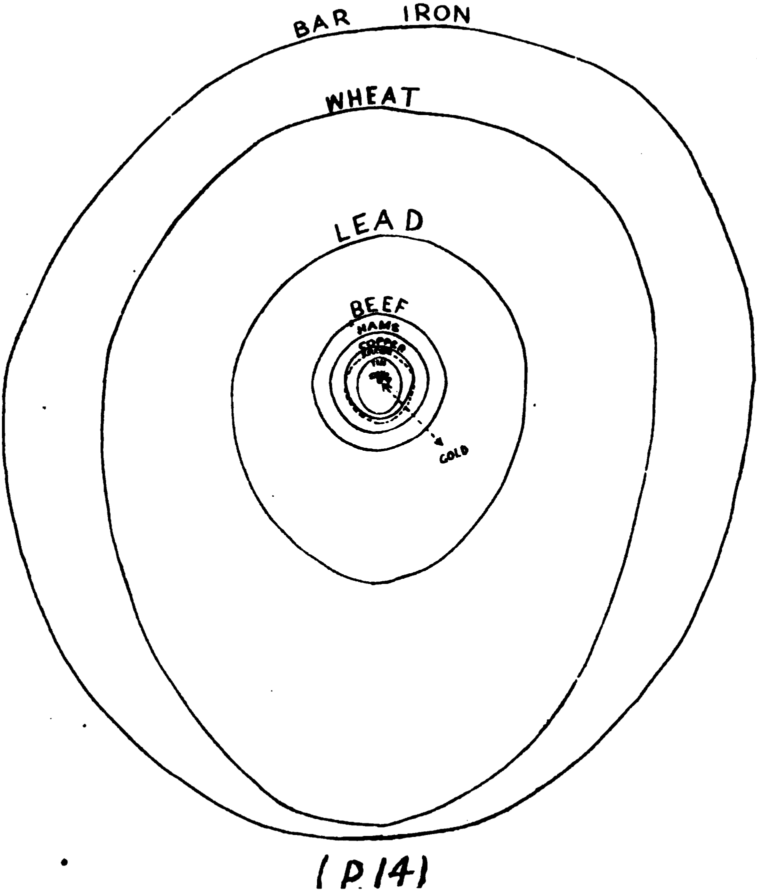
D)

AVERAGE WEIGHT PRODUCE PER MAN PER YEAR TONS
0.001405
0.032
2.001
9.46 : 9.52
10.78 : 11.18 : 11.18
40.8
72.9
124.07
252.0

VALUE ORBITS OF EQUIVALENCE OF VARIOUS COMMODITIES IN RELATION CENTRAL UNIT OF VALUE (GOLD) AND TO EACH OTHER

THE RESPECTIVE ECCENTRICITIES INDICATE THE DIFFERENCE OF PRICE-RANGE BETWEEN YEARS 1870 & 1893.

I^{A}



(P 141)

compared with the centre gold and with the respective value-orbits of silver, tin, wheat, and potatoes, because the experience of the producing industries of England and Tasmania during the last ten years proves that one *hand* during a year on the average can produce:—

ACTUAL.		EQUIVALENT RATIO TONS.
330	tons coal	234,800
0·001405	of a ton of gold	1
0·032	of a ton of silver	22·75
2·001	tons tin (metal)	1,424
9·52	tons wheat	6,776
40·8	tons potatoes	29,040

It is remarkable, notwithstanding the local differences of market prices and rates of current wages of the different industries, how closely the ratio of producing effort, taken inversely, agrees with the ratios of the selling prices in the English market. Any person who takes the trouble to examine this matter closely must be convinced that it amounts to a perfect demonstration that Cost of Production is the Primary Law which determines and regulates Economic Prices or Values, and that this law *can alone account for the remarkable permanence of the ratios of equivalent exchange weights of the principal commodities in relation to gold and to each other.*

It also alone satisfactorily accounts for the constancy or varying eccentricities of value-orbits over long periods caused by the rise, fall, or stationariness of prices of different commodities.

The True Cause of the Recent General Decline of Prices.

Persons who are unable to afford the time to give more than a superficial examination of such an important economic subject as the Recent General Decline of Prices in respect of which we are constantly deluged with the controversies of loose and inexperienced writers, may be apt to refer, without sufficient reflection, certain effects to one out of several possible causes.

Uniform decline of Prices.

For example, uniform decline of prices of commodities might be produced by any one of four very different conditions as follows:—

(1.) By a *uniform reduction* in cost of producing various commodities, with the exception of gold, whose cost of production is assumed to remain unchanged.

(2.) By cost of production *remaining unchanged* in regard to all commodities, excepting gold, whose cost of production had increased absolutely.

(3.) By a *uniform increase* in cost of production of various commodities, but associated with a still more marked increase in the cost of producing gold.

(4.) By a *uniform reduction* in the cost of producing various commodities, excepting gold, whose cost of production had declined at a lesser ratio.

(Diagram II.)

Now, whether we accept or reject one or other of these four possible causes, the relative purchasing power of commodity over commodity, excepting gold, would not be disturbed in the slightest degree. Even in respect of gold, it is only the industrial part which would be economically altered. The position reserved for money, by its appreciation, relatively, as in example 1 and 4, and absolute appreciation as in examples 2 and 3, would not in any way disturb their exchange values with each other in any way.

If nominal rates of wages and nominal profit fell uniformly, or rose uniformly with prices under all these differing conditions, the wage-earners' or investors' purchasing power would also be undisturbed, however higher or lower his nominal wages or rates of profit might be. But if nominal wages and nominal profits remain stationary while nominal prices fell generally, the industrial world would be greatly improved, because it would mean a real increase in the purchasing power of man's services. And as fully 70 per cent. of breadwinners buy commodities with services, not with commodities, we have no reason to doubt the largeness of the benefit to mankind from a general reduction of prices of commodities under such circumstances.

Any disturbance or depression of trade is therefore due to other well-understood economic causes, occurring periodically in cycles, and is in no way due to a general decline in prices.

Decline in Prices, Not Due to Absolute Appreciation of Gold.

Although there is a very marked decline in recent years in the prices of commodities, the rate of decline is far from being uniform in respect of different commodities.

II

ILLUSTRATIONS SHOWING THAT SIMILAR RELATIVE EFFECTS May be produced by VERY DIFFERENT CAUSES

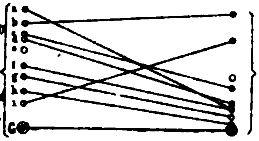
REFERENCE :- G *indicates Gold*
a.b.c.d &c. - *other commodities*

PURCHASING POWER OF GOLD

PRICES OF OTHER COMMODITIES

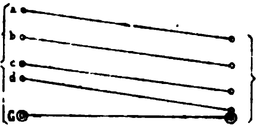
— EXAMPLES —

I P.P. increased, lowered or stationary accordingly as prices of other commodities, have fallen, risen or remained stationary, its own cost of production remaining stationary or unchanged.



Some increasing irregularly a few stationary the larger number falling irregularly P.Power over Gold & with each other varying as the prices vary & as the cost of production.

II Cost of Production Remaining Stationary Increased Purchasing Power over other commodities



Falling Uniformly relative to Gold Purchasing Power over each other unchanged owing to cost of production having fallen uniformly in all industries

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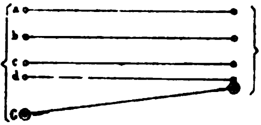
III Appreciated or Increased P.Power owing to increased cost of production.



Produces the same results as indicated by example II but owing to cost of production remaining unchanged in all industries

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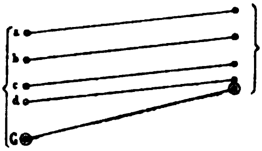
IV Greatly appreciated P.Power owing to a correspondingly great increase in cost of production



Produces the same results as indicated by example II but owing to cost of production having uniformly risen in all industries but with a smaller intensity than the current rise in the cost of production of Gold

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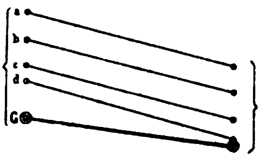
V Appreciated or Increased P.Power even with reduction in cost of production



Produces the same results as indicated by example II but owing to cost of production having uniformly fallen in all industries but at greater rate of intensity than in the con-current fall in cost of production of Gold.

(P 15)

Thus, between 1873 and 1893,

The price	of	Steel Rails	declined	46	per cent.
„	„	Cotton	„	46	„
„	„	Tea	„	43	„
„	„	Wheat	„	39	„
„	„	Sugar	„	37	„
„	„	Beef	„	4	„
„	„	Butter	„	6	„
„	„	Coal	„	17	„
„	„	Potatoes	increased	1	„
„	„	Copper	„	5	„
„	„	Tobacco	„	4	„
„	„	Fish	„	11	„
„	„	Coffee	„	56	„
„	„	Salt	„	59	„

This demonstrates that the fall in price of important articles, such as rails, cotton, tea, wheat, and sugar, cannot be due to the alleged appreciation of gold, for the latter cause would tend to produce a uniform fall in all prices.

If this be true, and if it be also admitted that cost of production is the true primary law of economic value or price, then it may be confidently affirmed that any attempt made by governments to fix arbitrary laws for determining the relative exchange values of any two commodites—such as gold and silver as in the scheme of bi-metallism—would be as futile as to pass arbitrary laws for determining their absolute specific gravities. Of course, I except the useful *token* relation of silver to gold, where one is subordinate to the unit standard, and limited in amount of tender as money.

The true cause of decline in prices is mainly due to the increasing improvements in steam, chemistry, electricity, and labour-saving machinery and forces, whereby man's labour is year by year made more effective, his reward is made greater, and his wants more abundantly satisfied in proportion as prices of commodities decline. Whatever local injury is now done to particular countries, or to particular industries in any one place, is due to the introduction of more favoured competitors in the same region, or in the same branch of industry, and not to the causes which are so frequently alleged. As a single example of the wonderful advantage to the effectiveness of man's labour by the introduction of labour saving forces and machinery, let us take the case of steam. It is estimated that the steam force now employed as an auxiliary to man's labour has multiplied the original power more than fifteen fold. When we realise that in the United Kingdom alone, since 1840, 8,600,000 additional horse-power is employed in transport, and in other industrial directions, represents the added nominal force of

103,000,000 of workmen, or fully six times the working force of all breadwinners in the United Kingdom, need we be surprised to find that even the effective power of the agricultural labourer, who is not so highly benefited as the artisan class, has been increased 42·93 per cent., and that fewer hands, therefore, are now required to cultivate each acre. Ought we not to expect, also, as we find it to be, that the new facilities must have immensely cheapened transport and cost of production; raised wages and purchasing power; increased the average consumption; and greatly improved the standard of living of the labourer. By such improved conditions, the United Kingdom is now better enabled to employ, feed, clothe 38 millions than in the year 1841, when there were 10 millions less to employ, feed, and clothe.

Conclusion.

In conclusion, I may be permitted to quote the following interesting passage from the author of "RECENT ECONOMIC CHANGES" (David A. Wells), who is acknowledged to be one of our most distinguished economists, in order to show that my own opinions are in harmony with those of the most advanced economic writers of the day. Mr. Wells, in his concluding summary of "The Single *versus* the Double Standard," states: "To comprehend the phenomenal reduction in the prices of the world's great staple commodities which has taken place in recent years, it is essential to *look for and consider more potent and extensive causes than any variation in the volume or relative values of the money metals,* great as they may have been."

Mechanical and chemical appliances have been invented, developed, and applied for the production and distribution of commodities within the last quarter of a century, which prior to that time had hardly formed the subject of rational speculation. The prime object of all these inventions and discoveries, *the great stimulus that led to their realisation, was to Cheapen cost, or, what is the same thing, reduce prices.* And the measure of the value of any new industrial method, invention, discovery, appliance, or development is the extent to which these results are effected by it.

Thus, the "prices of cloth fell when the spinning-wheel and the hand-looms were superseded; the price of travelling when steam superseded horses and the power of the wind. The prices of all the world's great staple commodities fell when steam connected the chief sources of their supply with the market places of all nations, and made possible the wide distribution of perishable products. The prices of all things, again fell *pari passu,* with the growth of financial institutions established to create the supply and use of metallic money."

"The investigations of Mr. Atkinson show that 'while one-half the present effort to sustain life consists in the effort or cost of obtaining food, that effort, great as it still is, is so much less than it was prior to 1860 as to make it almost incapable of expression in specific terms. In 1860, the greater part of the wheat now consumed in Europe could not have been moved a hundred and fifty miles without exhausting its value ; now wheat is moved half-way round the world at a fraction of its value.' The preservation of food by artificial methods, which to an extent is equivalent to its increase supply, has also been to a very high degree perfected."

"In the production of materials for clothing, vast areas of new territory have been added to areas formerly occupied for the production of cotton and wool; while, in the case of cotton, the change from slave labour to free labour alone has greatly reduced its cost of production in that country whose supply determines the price for the world. 'In the conversion of cotton and wool into fabrics it can be proven that one factory operative can do four times the work that one corresponding operative could accomplish between the years 1840 and 1850; while the invention and application of the sewing-machine has reduced the time and labour cost necessary for the conversion of cloth into clothing in vastly greater measure.'"

"In the case of the useful metals, iron, steel, copper, lead, tin, and quicksilver, the revolution which has occurred in consequence of the discovery and opening up of new mines, the application of new methods of smelting, and the facilities for transportation *at low cost*, have unquestionably reduced the cost (price) of all these products to as great an extent as that of any other class of commodities."

Mr. Wells then concludes his argument as follows :—

"To suppose, now, that a change in the relative value of the two precious metals—gold and silver—a change which has not in any degree restricted their natural supply or diminished their monetary or industrial uses, has exercised a concurrent superior and predominating influence in respect to the prices of all other commodities, or services, would seem to be almost incompatible with the clear exercise of one's reasoning faculties."

I am glad to be be in complete accord with the views so admirably set forth by Mr. Wells, and I am, at the same time, fully convinced that any cause which tends to check the influences which have beneficially cheapened commodities to consumers, also tends to check the world's progress in material welfare.

DISCUSSION.

Mr. A. J. Ogilvy said:—Mr. Johnston's opening statement (condensed) is that cost of production, not demand and supply, primarily determined prices. Later, he qualified that by excluding things the cost of which was determined by scarcity alone, confining it to things which could be increased (indefinitely, I suppose), and where competition operated without restraint. In short that, just as south of the tropics the wind would always blow from the west if there were no land to disturb, and just as every planet's orbit would describe an ellipse if there were no other planets to perturb, so price would always represent cost of production measured in labour if there were no natural scarcity or artificial interference. Mr. Johnston has proved this conclusively, but the case thus qualified seems so plain from the mere statement of it that one was surprised to hear that it required proof, and I suspect that the dispute, where there is any, arises from neither party quite understanding the other's position; for the law of demand and supply and cost of production are not rivals at all, but each is the complement of the other. There is not a farmer or shopkeeper during the bad times whom you will not hear recognising clearly the first half of the law of demand and supply, viz., that people will not go on producing goods for less than their cost of production; and though he may not quite so quickly recognise the second half, viz., that trade competition will not allow anyone to continue getting more than cost of production (plus margin of profit); this is only because business in real life is so full of monopolies, natural and artificial, legitimate and illegitimate, that he takes these disturbances as matters of course, and does not trouble himself to recognise that, where there is a continuous and excessive profit, there *must* be a monopoly of some sort, otherwise other people would have rushed into the business and brought profits down. Still he sees it plainly enough directly it is pointed out. So that he accepts the law of cost of production in full. For all that he sees at the same time that when things that are wanted are plentiful they are cheap, no matter why they are plentiful; and that when they get more plentiful still, no matter why, they get cheaper still, and *vice versâ*; and also that if they are less wanted (supply remaining the same), they again also get cheaper. In short, he also believes in the law of demand and supply, and attends chiefly to that as the broader law that includes and covers the cheaper. For the law of demand and supply is this—that just as the steam, as such, is the sole governing power of the movements of the piston-rod, notwithstanding that behind the steam is the fire that creates the steam, so the ratio between demand

and supply, as such, was the sole governing power of the movement of price, notwithstanding that behind demand and supply was cost of production that regulate supply. As the fire can only influence the piston-rod through the steam, so cost of production can only influence price through supply. Only there is this difference, that whereas fire only can create steam, other things besides cost of production determined supply. So that it is demand and supply, as such, only that determine price. To show this, take first reduced cost of production without increase of supply. Suppose I own the Blue John Mine, the only mine in the world that yields Derbyshire spar, and that I discover a way of reducing the cost of the work by half, but do not increase my output, only lessen my expenses, then demand and supply being unaffected the price remains unaltered, notwithstanding the reduced cost of production. Or suppose I discover a process by which I can make silk from mulberry leaves direct and keep my process secret without increasing my output, the same result happens. Now take increased supply without reduction of cost. Suppose a diamond field, where the difficulties of finding the diamonds are so great that only a limited number of people take to the business, and the price of diamonds stands at so much; and suppose now another diamond field, just like it, is discovered elsewhere with just the same difficulties and the same profits; then about the same number of people start diamond hunting there, so the supply of diamonds being doubled the price falls, notwithstanding that cost of production is exactly what it was. A law like this of demand and supply covers all cases, disturbances included, is at least as important as forming, one may say, one that, like cost of production, can only be applied after all disturbing influences have been excluded. Economics, to be worth studying, must be more than an intellectual exercise for the few, it must afford a useful guide for the many; and just as the sailor wants to know not how the winds *would* blow if things were different and there were no land (though that is good and useful, too, in its way), but how and why they DO blow so variably, so uncertainly, so bewilderingly, so what the man of the world wants to know is not what prices would be if things were different and there were no disturbing influences, but what does actually determine them under all the innumerable and ever-present influences of natural scarcity, artificial monopoly, privileged obstruction, protective duties, rings, and syndicates, sudden changes of fashion, slow changes of custom, disappearance of species, and a thousand other interfering agencies, all which are not confined to a one per cent. class of articles, but enter more or less at one stage or another into every single article of commerce. And the simple law of demand and supply covers them all; all at least with (so far as I can see) one solitary exception. As to the exclusion of things the value of which is determined by scarcity, the doctrine of demand and supply is that the value of EVERYTHING is determined by its scarcity as compared with the demand for it. If there is no demand for it it will have no value, no matter how scarce it may be. But the exclusion is evidently meant to apply to things that are wanted, and that are obtainable to a certain extent, yet the supply of which cannot be increased. But the disturbances and interferences with free production are not confined to these articles (if any such articles there be), they appear everywhere. Food, clothing, and houses, for instance, are typical examples of the things that, in theory at any rate, can be increased indefinitely. There is no natural scarcity of these things, but there is a terrible artificial scarcity. This is why we are saddened with the sight of unemployed men, without food, which they could and gladly would produce; without clothes (beyond what is on their backs), which they would gladly make; without homes, which they would gladly build—if they were allowed. All these, and nearly every other theoretically obtainable good thing which men cannot get are scarce because the opportunities to produce them are *made* scarce; and the man who could but may not produce them, if he is to get them at all, must pay a high price for them; not perhaps a high price measured in money, but a high price measured in labour, that is, he must give many more hours' work for them, or for the money to buy them, than he need give but for obstruction. Now we want a law that shall cover all these cases. The law of demand and supply is the only one that does so. Now take the three examples given to dethrone demand and supply from its hitherto recognised position: 1st. Wheat, the demand for which, as indicated by consumption, rose, after 1840, in 47 years by one-third, while its price fell to half. Why? Through the law of demand and supply. Because increased supply (no matter from what cause) had brought down price, and in doing so had stimulated demand. For it was about that time that the prairie lands of North America began pouring their supplies into the English market. It was the increased supply as such, not the diminished cost as such, that produced the result, for if a ring had bought up the imports and held back half, or if foreign war vessels had intercepted half, the price would not have fallen as it did, notwithstanding the diminished cost of production. And here I may say, though it is not strictly relevant to the question before us, that I doubt whether there was any diminished cost of production measured in labour. I doubt much whether it took any less labour to raise a bushel of wheat on the prairie, send it by cart to the railway, by rail to the seaports, and by sea to the English market, than it did to raise a bushel *at* the English market. A large part of the previous price represented rent. Not that the high rents CAUSED the high price, it was the scarcity that did that; but the landlord got the benefit all the same, and when the increased imports brought down the price, the landlord lost and the consumer gained the difference. As to the next example, meat, the same argument applies. The arts of tinning and freezing meat had been discovered, and shipments of live stock greatly increased. The increased supply, not the reduced cost, checked the rise of price. As to the third example, the increased rate of wages coupled with increased purchasing power, that is too wide a question to enter on here. I content myself with remarking that the increased wage and increased purchasing power were a good deal less than they appear, being largely discounted by increasing rent, by increasing irregularity and uncertainty of employment, and in many, especially in the most conspicuous cases, by contributions to the war fund of the Union, by which the rate of wage was kept up. However, let us keep to the main point, which is that, looking at the matter broadly and taking price as a whole, as it actually is with all its disturbing influences, not as it might be without them, it is demand and supply as such that determines it; cost of production acting only by affecting supply, and so disturbing the ratio, besides being only one factor out of many, though no doubt the chief one, in affecting supply.

BOTANICAL NOTES.

By L. Rodway.

(*Read November* 25, 1895.)

In a paper I had the honour of reading early this year, I alluded to a grass from Adamson's Peak that appeared distinct from any described form. I am now convinced it is an alpine variety of the scarce grass described by Brown as *Tetrarrhena juncea*, and as such is of greater interest than if it had been specifically distinct, all the more so to us as it upholds the wisdom of our respected botanical head, Baron von Müeller. Brown, guided by a similar train of thought to that which directs more modern specialists, was a great genus maker as well as species maker. There was rather a tendency to make genera on artificial lines. Thus he removed from the well marked genus *Ehrharta*, of Thumberg, sundry forms that differ inessentially from that genus in bearing 4 instead of 3 or 6 stamens in the flower. Of these those that bore a loose inflorescence he placed in a genus as *Microlæna*, and those whose flowers were arranged in a spike or spike-like raceme were formed into a genus *Tetrarrhena*. A long time after this Gunn found a grass undoubtedly new that was close to *Microlæna*; but having but 2 stamens, Hooker in describing it thought it necessary to erect a new genus, *Diplax*, for its reception. Müeller, following Sprengal, has long ago returned these genera to *Ehrharta*. The grass I found on Adamson's Peak is in all essential details a stunted *Tetrarrhena juncea* of Brown, but it has a panicled inflorescence, and the androecium is reduced to a single stamen, making it necessary to form a new genus for an apparent variety, or to accept the teaching of von Müeller and return to the single genus *Ehrharta*.

Lepturus cylindricus, Trin. This littoral and marsh grass, which is common to temperate Australia, Cape of Good Hope, and the Mediterranean, is widely distributed in Tasmania, with its ally, *L. incurvatus*, Trin., from which it differs in the spikelets possessing a single outer glume. It is doubtless indigenous.

Cynodon dactylon, Pers., referred to in the appendix of Spicer's Handbook as a recent introduction, has so long been known in out-of-the-way localities that it is better considered indigenous. Bentham so treats it as Australian in his Flora Australiensis.

Amongst introduced grasses that are widely spreading are :—

Kœlaria phleoides, Pers., throughout central districts and islands of Bass Straits.

Bracleypodium distachyum, R. et Sch., on the Domain in and about the Botanic Gardens. Referred to in Spicer as a *Triticum*.

Gastridium lendigerum, Beauv., the common nitgrass of the [illegible]

Page 103, line 5.—For bracleypodium, read *brachypodium.*

" 104 " 33.—For natricaria, read *matricaria.*

" " " 39.—For lepdium, read *lepidium.*

" " " 31.—For arvensis L. restbarrow, read *arvensis L. restharrow.*

Nut shining, obscurely triquetrous. Hypogynous scales thick and short below the nut as in *L. lineare.* Common in poor soil, in healthy and stony places in Tasmania.

It is with considerable hesitation I describe this as specifically distinct from *L. lineare*, R. Br.; but it could not be included in that species without also including both with *L. laterale*, R. Br., a clubbing hardly justified though natural.

Carex barbata, Boott. Tufted. Leaves about 1ft. long, rather narrow, without a conspicuous mid-rib, margin scabred. Stems slender, 12-18in. high. Spikelets few, stalked, the upper one male, but often bearing also a few female flowers; the female spikelets often with few male flowers at the apex, about 1in. long. Glumes and utricles similar to those of *C. gunniana*, Boott, but the latter only half the size.

Common in swamps at Claremont and Longley.

This species, which I apprehend to be the *Carex barbata* of Boott referred to in Bentham's Flora Australiensis, lives with *C. gunniana*, and though similar in general habit, is most undoubtedly distinct from that species.

Corysanthes unguiculata, R. Br. This rare and interesting little orchid occurs near Kingston, in damp heaths, and will probably be found in suitable localities.

In the transactions for 1893 I drew attention to the artificial basis upon which the species *Thelymitra longifolia*, Forst., and *T. aristata*, Lind., besides numerous other now suppressed species, were maintained to be distinct from *T. ixioides*, Sw., I endeavoured to point out by means of dissections taken from numerous plants the totally unreliable details upon which those species were founded. I have since obtained specimens from Clarke Island, Bass Straits, and near Strahan, in which the upper hooded portion of the column wing is exceptionally well developed, and the lateral lobes are entirely suppressed. This necessitates the raising of this variety into specific rank, or reducing the forms *T. aristata* and *T. longifolia* to inconstant varieties of *T. ixioides*, Sw.

Amongst introduced plants the following deserve attention:—

Trichonema roseum, Ker. A pretty little lily-like iris, with pinkish mauve flowers, steadily disseminating itself in pastures. It is often passed by as a pink form of the harmless little white lily of spring, but I am assured by von Müeller that it is poisonous, and should be eradicated.

Euphorbia larthyris, L, the caper-spurge, probably responsible for some of the cattle poisoning that has taken place lately. It is naturalised in many parts. Its powerful cathartic qualities are dangerous.

Nepeta cataria, L., catmint, is found in some parts.

Gilia pungens, Hook., of South America, a prickly little herb of certainly no useful qualities, has made its appearance in the central districts.

Helminthia echioides, Gaert., a useless thistle and *Ononis arvensis*. *L. restbarrow*, whose habit is well expressed by its name, are also with us.

Hatricaria discoidea, D.C., a composite with conical inconspicuous flower-heads, is becoming very common about the suburbs of Hobart. It has medicinal properties like its allies.

Erigeron linifolius, D.C., is also a common composite but harmless weed very common about Hobart.

Lepdium draba, L., is common at Cornelian Bay and Sandy Bay.

Linum catharticum, L., is establishing itself in one or two places.

ON THE NEW GENUS PETTERDIANA.

By John Brazier, F.L.S., C.M.Z. Soc., London, Corr. Mem. Roy. Soc., Tas.

In the year 1887 Mr. C. F. Ancey, in his descriptions of new genera and sub genera of the Helicidæ, published in the Conchologists' Exchange, Vol. ii., p. 22, defined and named a sub genus of *Endadonta* from the Caroline Islands under the name of *Brazieria*. Mr. W. F. Petterd, in his contributions for a systematic Catalogue of the Aquatic Shells of Tasmania in the Proc. Roy. Soc., Tasmania, p. 76, 1888, defined and named a new genus of the family *Amnicolidæ* under the name of *Brazieria*. Mr. Ancey's name having priority, I take the pleasure of re-naming the aquatic Tasmanian genus after my very esteemed friend, correspondent, fellow voyager and companion, Mr. William Frederick Petterd, of Launceston, Tasmania.

PETTERDIANA, Brazier.

"Shell globosely rounded, solid, imperforate ; spire small, body whorl large ; aperture very oblique, effuse ; outer lip acute, inner lip thickened ; operculum horny, subspiral, animal (?) "

Type : AMPULLARIA TASMANICA, Tenison-Woods.

PETTERDIANA TASMANICA, Tenison-Woods.

1876. *Ampullaria tasmanica*, Tenison-Woods, Proc. Royal Soc., Tasmania, p. 117.

1881. *Amnicola tasmaniæ*, Tate and Brazier, Check List of the Fresh Water Shells of Australia, Proc. Linn. Soc., N.S.W., vol. vi., p. 563.

1888. *Brazieria* (non Ancey, 1887) *tasmanica*, Petterd, Proc. Royal Soc., Tasmania, p. 76, pl. 1, fig. 1.

1890. *Brazieria* (non Ancey, 1887), Petterd ; Johnston, Proc. Royal Soc., Tasmania, p. 90.

1890. *Amnicola ? (Brazieria) tasmanica*, Tenison-Woods *(Amnicola)*, Johnston, l.c., p. 138, No. 304.

Hab. Abundant upon stones in a small tributary of the Arthur River, west of Mount Bischoff. (Messrs. James Smith, W. F. Petterd, R. M. Johnston.)

Ha

SOME ADDITIONS TO THE MOSS FLORA OF TASMANIA.

BY W. A. WEYMOUTH.

PART II.

(Read November 25th, 1895.)

In continuing the subject opened by me in the proceedings for 1893, I desire to acknowledge my further indebtedness to Professor V. F. Brotherus, of Helsingfors, from whose third series of "New Species of Australasian Mosses," as published in *Oefversight af Finska Vet.-Soc. Foerh*, Helsingfors, 1895, I obtain the descriptions of New Mosses given under the first following heading. It is a pleasure to call attention to the fact that the writer's name does not appear alone in connection with these new species, his friends, Mr. T. B. Moore, of Strahan, and the Rev. John Bufton, of Dunally, bearing him company. This portion of the paper adds fifteen (15) new species, making in all twenty-eight (28) new mosses since Mr. R. A. Bastow's list.

The second heading notes two new varieties. The third deals with mosses already known elsewhere, but now for the first time recorded for Tasmania. One of these, *Barbula rubella* (Hoffm.), Mitt., is of the more interest in that it is also thus first recorded for Australasia.

The fourth part gives descriptions of four new mosses the names only of which appeared in my 1893 paper. These are obtained from the sources in which the respective authors published their original descriptions.

NEW MOSSES.

14. *Sphagnum maximum*, Warnst., n. sp.

Hab.—Tasmania, locality unknown. (Herb. Mitten, No. 5.)

Writing to me on the 24th Jan., 1893, Mr. W. Mitten said:—"Packing material for apples from Tasmania supplied me with a Sphagnum, which I sent to Mr. Warnstorf, who said it was new."

On application to Mr. Warnstorf he was good enough to send me a small specimen of this moss, with the above name.

15. *Sphagnum moorei*, Warnst., n. sp.

Hab.—Kelly's Basin and Gordon River, Macquarie Harbour, on damp ground, 1893, T. B. Moore, No. 54. (Herb. W.A.W., No. 1602.)

16. *Andreæa amblyophylla*, C. Müll. in sched., n. sp.

Dioicous; in rigid, red-brown or black-brown cushions to 2 cm. high, easily falling to pieces. Stems erect, dichotomously branched; the branches fastigiate, obtuse, densely leaved. Leaves imbricate when dry, erecto-patent when wet, oblong-lanceolate or ovate-lanceolate, subcucullate, rotund-obtuse, coarsely papillose at back, nerveless, margin quite entire; cells very much thickened, the superior and marginal round, the middle narrow-oblong, and the basal linear. Perichaetial bracts much larger than the leaves, convolute, rotund-obtuse.

Hab.—On rocks, The Glen, Knocklofty, Hobart, W.A.W., Nos. 262, 475, 476, 477, 1618. (Also R. A. Bastow and A. J. Taylor in Herb. W.A.W., Nos. 1301, 1302.) Top Mount Wellington, W.A.W., Nos. 1634, 1635, 1643.

(Also New South Wales, Blue Mountains, T. H. Whitelegge, No. 302.)

Similar in habit to *A. petrophila*, Ehrh., but readily distinguished by the rotund-obtuse and subcucullate leaves.

17. *Dicranum rigens*, Burch. Broth., n. sp.

Hab.—On rock, Ploughed Field, Mount Wellington, 1891, and on log, Lauriston Gully, Kangaroo Point, 1889, W.A W., Nos. 767 and 160.

18. *Dicranum integerrimum*, Broth. Geh., n. sp.

Dioicous; in dense, pale yellow, somewhat shining tufts to 7 cm. high, for the most part buried in sand. Stem erect, densely leaved, sparingly radiculose. Leaves roughly patent, not at all subsecund, smooth at back, deeply canaliculate-concave, from an ovate-lanceolate base subulate, margins erect, connivent above, quite entire or having a few denticles at apex only; nerve very thin, indistinct at base, excurrent, with smooth back; cells everywhere elongate, narrowly linear; the marginal very narrow, hyaline, forming a somewhat wide border, the alar numerous, ventricose, fusco-aureate, all quite smooth. The rest unknown.

Hab.—Jones' Track, Sprent River, West Coast, on sandy button-grass plains, T. B. Moore, No. 58. (Herb. Sir F. von Mueller, and also W.A.W. No. 1563.)

"This moss," says Mr. Brotherus, "appears to be nearest to *D. angustinervis*, Mitt., which is known to me only by the description and figure. From that and other kindred species it is separated by the quite entire leaves."

19. *Dicranum eucamptodontoides*, Broth. Geh., n. sp.

Dioicous; robust. In rigid, dense, wide-spreading tufts, easily falling to pieces, for the most part buried in sand, fuscescent, the apex yellowish-green, shining. Stem to 7 cm. high, fragile, densely terete-leaved, sparingly radiculose, simple or branched; branches short, and shortly cuspidate. Leaves scariose, imbricate when dry, erect when wet, cymbiform-concave, ovate-oblong, shortly acuminate, 4—5 mm. long and 1·5—2 mm. wide, margins erect, connivent at apex, quite entire; nerve thin, indistinct at base, wider above, back prominent, smooth; cells elongate, narrow, porous between, the marginal very narrow, forming a narrow hyaline border, the basal fusco-aureate, the alar numerous, very incrassate, fusco-aureate, often discoloured, all quite smooth. Perichaetial bracts slightly exserted, longly vaginant, convolute, very obtuse; nerve indistinct. Seta, short, 1 cm. high, yellowish red, quite smooth. Calyptra cucullate, somewhat fuscous, apex rather scabrous, base truncate, entire.

Hab.—Jones' Track, Macquarie Harbour, on sandy button-grass hills, July 1893, T. B. Moore, No. 60. (Herb. Sir F. von Mueller, and also W.A.W. No. 1603.)

"This very remarkable species," says Mr. Brotherus, . . "I have classified, though indeed with much hesitation, among the genus *Dicranum*, because its very young fruit is somewhat curved, and the perichaetial leaves are much shorter than is the case with the species of the genus *Eucamptodon*."

20. *Pottia tasmanica*, Broth., n. sp.

Autoicous; gregarious, very small, fuscous-green. Stem scarcely 1 mm. high, radiculose at base, densely leaved, simple. Leaves when dry imbricate and indistinctly spirally twisted, when wet erect, strict, somewhat fleshy, concave, ovate-oblong or oblong, shortly acuminate or obtuse, muticous or very shortly cuspidate by the excurrent nerve, 0·95 mm. long and 0·38 mm. wide, margins strongly revolute (except at base); nerve rufescent, thin at base, thicker and better developed above, shortly excurrent; the marginal cells rectangular, hyaline, smooth, the upper rotund-hexagonal, c. 0·015 mm. in diameter, chlorophyllose, very papillose, obscure. Perichaetial bracts similar to the leaves. Seta 3 mm. high, yellow, very thin, quite smooth. Capsule erect, minute, oblong, fuscous, when dry somewhat shining, corrugated; exannulate. Peristome simple, pallid, rudimentary; teeth very short, 0·05—0·07 mm. high, truncate, very densely papillose; spores 0·025 mm., lutescent, coarsely pustular; operculum shortly conic, obtuse; calyptra fuscous at apex, scabrous.

Hab.—River Jordan, near Brighton, on earth, W.A.W., No. 1129.

21. *Glyphomitrium latifolium*, Broth., n. sp.

In somewhat dense tufts, easily falling to pieces, dark green, not at all shining. Stem to 2 cm. high, erect, flexuous, radiculose at base, densely leaved, simple or dichotomous. Leaves when dry crispate-appressed, when wet recurved-patulous, carinate-concave, from a scarcely dilated base oblong, rotund-obtuse, c. 3 mm. long and c. 0·85 mm. wide, margins erect, quite entire, slightly undulate; nerve rufescent, somewhat thick at base, gradually narrowing above, vanishing below the apex; cells rotund, c. 0·010 mm., the basal minute, quadrate, the intramarginal forming a lutescent border composed of from 4—5 series of rectangular cells, the intralimbate smaller, rectangular, less incrassate. The rest unknown.

Hab.—New Town Rivulet, on water-washed rocky bank, W.A.W. Nos. 1484, 1891, 1896.

"A very distinct species," says Mr. Brotherus, "readily distinguished by the form of the leaves."

22. *Macromitrium* (*Goniostoma*) *weymouthi*, Broth., n. sp.

Slender, prostrate, interwoven, bright-green, finally ferruginous. Stem longly creeping, vaguely branched; branches crowded with short, straight, or somewhat curved branchlets, densely leaved. Leaves when dry appressed, incurved at apex, spirally twisted, when wet erecto-patent, oblong-lanceolate, acute, the lower margins more or less revolute, quite entire. Nerve lutescent, vanishing below the apex; the basal cells elongate, very incrassate, and their cavities very narrow, those above the middle of leaf rotund, very incrassate, their cavities very minute, all pellucid and quite smooth. Perichaetial bracts erect, larger, acuminate. Seta erect, curvate-flexous, 8—15 mm. high, yellow, quite smooth; capsule erect, oval, plicate when empty, small mouth, dull brown; peristome simple, the teeth arising below the orifice, short, papillose; operculum rostrate, the beak scarcely more than half the length of the capsule; calyptra a sordid yellow, ferruginous at apex, glabrous.

Hab.—On wood, Porteus Gully, Queen River Road, Macquarie Harbour, and also Henty River, on branch of myrtle, 1891, W.A.W., Nos. 573-5, and 569.

"Nearest to *M. scottiæ*, C. Müll., but at once separated by the acute leaves, the vanishing nerve, and also the smaller cells."

23. *Macromitrium (Goniostoma) tasmanicum*, Broth., n.sp.

Autoicous; slender, prostrate, interwoven, bright green, when older fuscescent. Stem longly creeping, vaguely branched; branches crowded with short, straight branchlets, densely leaved. Leaves when dry crispate-appressed, not twisted; when wet erecto-patent, oblong-lanceolate, acute, the lower margins more or less revolute, quite entire; nerve lutescent, vanishing below the apex; the basal cells elongate, very incrassate, and their cavities very narrow, those above the middle of the leaf rounded, all pellucid and quite smooth. Perichaetial bracts larger, erect, acuminate. Seta erect, flexuous, 5—7 mm. high, pale yellow-red, quite smooth; capsule erect, oval, plicate when empty, small mouth, dull brown; peristome simple, the teeth arising below the orifice short, papillose; operculum ? calyptra yellow, fuscous at apex, glabrous, plicate.

Hab.—On wood, South Road Forest, Circular Head, 1892, W.A.W., Nos. 846, 1040, 1041, and on Mount Wellington, No. 121 (f. *lutescens*).

"Differs from the preceding species in the leaves being erect when dry, not spirally twisted; the less incrassate superior cells; and the shorter seta."

24. *Tayloria obtusissima*, Broth., n. sp.

Dioicous; in tall, dense tufts, interwoven with fuscous-purple tomentum, bright green, when young somewhat shining. Stem 9 cm. high, erect, loosely leaved, simple. Leaves roughly patulous, very concave, cucullate at apex, from a shortly spathulate base broadly ovate, subround-obtuse, 3—5 mm. long and 2·5 mm. wide; margins erect, minutely and obtusely serrulate above; nerve thin, lutescent, vanishing far below the apex; cells soft, lax, shortly and broadly oblong, the apical subrotund-hexagonal, the basal elongate, rectangular. Perichaetial bracts smaller, the margins of the inmost distinctly serrulate; nerve shorter; numerous archegonia. The rest unknown.

Hab.—Falls Track, Mount Wellington, March, 1891, W.A.W., No. 1797.

"A very fine and most distinct species, readily distinguished at a glance from *T. callophylla* (C. Müll.) by the very obtuse leaves."

25. *Calyptothecium buftoni*, Broth. Geh., n. sp.

Dioicous; fuscescent-green, shining. Stem creeping; branches to 10 c.m. long, flexuous, turgidly leaved, terete, obtuse, crowded with patent, terete, obtuse branchlets scarcely longer than 1 c.m., and turgidly leaved. Leaves when dry loosely imbricate, neither rugulose nor plicate, when wet patent, cymbiform, concave, oblong-oval, abruptly and shortly acuminate, margins erect, quite entire; nerveless; cells elongate, very narrow, chlorophyllose, the basal aureate, all quite smooth. Perichaetial bracts pallid, larger, erect, longly acuminate. Capsule immersed, broadly oval, pallidly fuscous, smooth. The rest unknown.

Hab. — Bathurst Harbour, West Coast, Rev. John Bufton, No. 91 (Herb. Sir F. von Mueller), and track to Hartz Mountains, No. 17.

"A very distinct and beautiful species, at once distinguished from congeners by the branches being crowded with branchlets."

26. *Hypnum (Rhynchostegium) moorei*, Broth. Geh., n. sp.

Dioicous; in dense, very broad, rigid tufts, bright or sordid green, somewhat shining. Stem elongate, vaguely branched; branches elongate, robust, terete, densely and squamosely leaved. Leaves scariose, when wet erecto-patent, concave, ovate, acute, margins erect, everywhere minutely serrulate; nerve from a wider base thinly vanishing above the middle; cells very narrowly linear, somewhat flexuous, chlorophyllose, the basal shorter and wider, the alar indistinct. The internal perichaetial bracts erect, somewhat reflexed at apex, from a vaginant base narrowly acuminate, the margins remotely serrulate at apex, loosely reticulate; nerveless. Seta 17 mm. high, somewhat straight, red, everywhere rough; capsule subhorizontal, from a short neck ventricose-oblong, pachydermous, pallid, smooth; peristome double, the outer teeth c. 0·66 mm. long and c. 0·08 mm. wide, rufescent, hyaline at apex, scabrid; the inner teeth yellow, papillose; the processes carinate, broadly perforate; the cilia in triplets, short, hyaline; spores 0.012—0·015 mm., ochraceous, quite smooth; operculum with an oblique beak shorter than the capsule.

Hab.—On rocks in running water, Guy Fawkes Rivulet (Hobart), the South George River (Gould's Country), and Deep Creek, Mt. Wellington, W.A.W., Nos. 945, 1608, and 1822. Moore's Track to Frenchman's Cap, West Coast, T. B. Moore, No. 39 (Herbs. Sir F. von Mueller and W.A.W.)

"A most distinct species, similar in habit to *H. rusciformi*, Weiss, but sharply marked off from it by the rough seta."

27. *Stereodon nelsoni*, Broth., n. sp.

Dioicous; in somewhat loose tufts, bright green, when old somewhat pallidly fuscous, shining. Stem firm, elongate, flexuous, loosely leaved, pinnately branched; the branches patulous, short and simple, or longer, and with few branchlets, distichously leaved. Leaves scariose, sparingly homomallous, rather concave, patulous, ovate or oblong-ovate, shortly and broadly acuminate, rather obtuse, margins erect, very minutely serrulate, the apex finely serrulate; two short nerves; cells elongate, very narrow, somewhat flexuous, the lowest basal shortened, aureate, the alar numerous, minute, very incrassate, all quite smooth. The rest unknown.

Hab.—On wood, The Den, Mount Nelson, 1890, male plant, W.A.W., No. 506.

"A very distinct species; related to *St. chrysogaster* (C. Müll), but easily distinguished by the form of the leaves."

28. *Fissidens sarcophyllus*, Burch. Broth., n. sp.

Hab.—On face of rock, on track below the Springs, Mt. Wellington, 1891, W.A.W., No. 772.

NEW VARIETIES.

1. *Orthotrichum lateciliatum*, Vent., var. *apiculatum*, Vent., n. var.

Hab.—On rock, Hobart Rivulet, 1892, W.A.W., No. 1548.

2. *Ulota lutea*, Mitt., var. *glaucescens*, Vent., n.v.

Hab.—On wood, McRobie's Gully, Hobart, 1892, W.A.W., No. 1532.

MOSSES NEW TO TASMANIA.*

26. *Ditrichum flavipes*, C. Müll.

Hab.—On earth banks, Cradoc-road, Huon, and Forestier's Peninsula, 1889, W.A.W., Nos. 156, 162, 179, 258.

27. *Barbula rubella* (Hoffm.), Mitt.

Paroicous and synoicous; caespitose, deep green above, ferruginous red below, slender, branched. Leaves curled when dry, patent and recurved when moist, the lower lanceolate, upper suddenly larger, from an erect concave base, lineal-lanceolate, acuminate, carinate, minutely papillose on both sides, the margin recurved; nerve terete, vanishing below or in the apex; cells at base pellucid, rectangular, above small quadrate and chlorophyllose. Perichaetial bracts longly sheathing, thin. Capsule erect on a long reddish seta, cylindraceous, rarely oblong or oval, leptodermous, pale brownish-green, finally reddish; annulus of two rows of large cells, very fragile; lid conic, with a short straight or slightly oblique beak; peristome on a short basal membrane, pale red, soft, of 16 flat linear teeth, rarely cleft or perforated, the articulations nodose and papillose. Antheridia usually naked in the axils of the perichaetial bracts. *Barbula*

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* That is, not recorded in Fl. Tasm., in Mitten's list of 1859 (Jnl. Linn. Soc. iv.), in Mitten's Australian Catalogue 1882, or in Bastow's Tasmanian mosses 1886.

rubella varies considerably in size and density, but is very uniform in the fruit, and always more or less red in the lower leaves.—Braithwaite's *British Moss Flora,* Vol. 1, p. 260.

Hab.—On a dead log, Lauriston Gully, Kangaroo Point, 1891, and on rocks, Hobart Rivulet, 1892, and New Town Rivulet, 1893, W.A.W., Nos. 711, 1220, 1485.

A European moss, not before recorded for Australasia.

28. ***Entosthodon cuspidatus*** (H.*f.*W.).—Fl. N.Z. ii. 91, t. 86, f. 3.

Stems ⅛in. high. Leaves spreading, nearly flat, ovate, acuminate, quite entire, nerve far excurrent. Seta pale, 1in. long. Capsule erect, pyriform, small, quite symmetrical; annulus 0; inner peristome imperfect; operculum nearly flat.—Hook. *Handbook N. Z. Fl.*, p. 450 (Funaria).

Hab.—On the ground, Carlton, 1889, W.A.W., No. 428.

(Also New Zealand, Bay of Islands, J. D. Hooker.)

29. *Philonotis fertilis*, Mitten, Kew Journ. Bot. viii., p. 260.

Hab.—Ben Lomond, 1886, E. J. De Bomford. (Herbs. Bastow and Taylor; W.A.W., No. 1304.)

30. *Bartramia strictifolia*, Tayl.

Stems an inch high, laxly tufted, erect, subsimple, at the base clothed with a dark-brown down, in the middle reddish-brown, at the tops glaucescent-green. Leaves imbricate, strict, subulate-setaceous, subserrulate, margin reflexed, the lower appressed, straight, the upper recurved. Seta slender, flexuous, above an inch long. Capsule erect, from a narrow base subglobose, striate, when young turbinate, inclined to one side; operculum convex, obtusely mamillate; inner peristome much shorter than the outer.—*Lond. Journ. Bot.* 1846, p. 54.

Hab.—On the ground, Bay View Paddock, Bellerive, 1889, W.A.W., No. 967 (var. *minor*).

31. *Brachymenium preissianum*, Hampe, Icones, p. 25.

Hab.—On face of stone wall, Garden Crescent Reservoir, Hobart, 1890, W.A.W., No. 502.

(Also West Australia, Preiss, Drummond; and Victoria, F.V.M.)

32. *Bryum creberrimum,* Tayl. Lond. Journ. Bot. 1846, p. 54. —Fl. N. Z. ii. 84.—Hook. Hand. N.Z. Fl. p. 442.

Dioicous; stems aggregate, reddish, erect, with long shoots. Leaves olive-green, lax, suberect, when dry erect, twisted and flexuous, lanceolate, acuminate, somewhat keeled, margin subrecurved, quite entire; nerve slender, excurrent as a very fine hair-point. Seta long, slender, flexuous; capsule nodding or pendulous, long, slender, cylindric, narrowed into the slender apophysis; operculum convex, mamillate.

"This differs," says Dr. Taylor, "from *Br. obconicum*, Br. Schimp., by the more elongated sterile shoots and their narrower leaves, and by the longer capsules, which are by no means obconical, but from a shrunken narrow apophysis are cylindrical."

Hab.—On the ground, near Richmond, 1888, and on wet bank, The Nut, Circular Head, 1892, W.A.W., Nos. 44 and 1068.

(Also West Australia and New Zealand.)

33. *Bryum erythrocarpoides*, Hampe and C. Müll., Linnæa 1853, p. 495.

Hab.—On wet earth bank, "Gentle Annie," Hobart Waterworks, 1892, W.A.W., No. 1216.

(Also Australia, F. v. M.)

34. *Bryum breviramulosum*, Hampe, Linnæa 1876, p. 311.

Hab.—On old log, Millhouse's Falls, Huon-road, 1893, W.A.W., No. 1467.

(Also Victoria, Sullivan.)

35. *Bryum pyrothecium*, Hampe and C. Müll., Linnæa 1855, p. 205.

Hab.—Bower Track, Mount Wellington, 1885, and Bay View Paddock, Bellerive, 1886, A. J. Taylor. On the ground, Fingal, and Guy Fawkes Rivulet, Hobart, 1888; on rocks near the Springs, Mount Wellington, 1890; and on the ground near Rocky Cape and at South-road Forest, Circular Head, 1892, W.A.W., Nos. 58, 94, 493, 541, 1063, 1076, 1078, and 1079.

(Also Australia.)

36. *Mniadelphus rotundifolius* (H.*f.*W.). Lond. Journ. Bot. 1844, p. 551.—Fl. N.Z. ii., p. 122, t. 93, f. 1.—Hook. Hand. N.Z. Fl., p. 493.—*Syn.*—*M. obliquo-mucronatus*, C. Müll. in litt.

Dioicous; small. Stem prostrate, ¼—½in. long, sparingly branched; branches compressed, slender, reddish. Leaves dark green, lax, spreading, crisped when dry, orbicular-ovate, apiculate; margin thickened, toothed; nerve reaching halfway; cells large, lax, hexagonal. Perichaetial bracts margined, toothed. Seta slender, ¼in. long, smooth. Capsule horizontal, narrow-oblong, pale; operculum with a slender straight beak, nearly as long as the capsule. Teeth of peristome yellow, with two rather distant subcylindrical dorsal ridges, forming the external lamina of the tooth; inner peristome without cilia; processes carinate, perforated. Calyptra fimbriate at the base, subpilose at apex.

"Closely allied to *M. dicksoni*, Hook., but differs in the smaller, roundish, denticulate leaves, more shortly apiculate. From *M. crispula*, H.*f.*W., which it also much resembles, it is distinguished by the rounder, much smaller, and denticulate leaves, with larger and more uniform areolæ."—Hooker.

Hab.—On logs, Sassafras Gully and Bower Creek, Mt. Wellington, 1888; and on wet wood and stones, Hobart Rivulet, 1893, W.A.W., Nos. 373, 376, 1585, 1586. On logs, Sophia Point and Gordon River, Macquarie Harbour, 1893, T. B. Moore, Nos. 27 and 53.

37. *Meteorium* (*Pilotrichella*) *billardieri*, Hampe, Linnæa, 1859-60, p. 637 (Neckera).

Stems turgid, elongate, pendulous, irregularly branched; branches short, about an inch, turgid, somewhat obtuse. Leaves turgidly imbricate, from a cordate base, cochleariform (inflexed at base and apex), quite entire; nerves two, short, distant. Perichaetial bracts few, lanceolate, involute. Seta short, thick. Capsule short, ovate; operculum conic, obtuse; teeth of peristome red. "Differs from *Neckera molle*," says Hampe, "in the more robust habit, the double-nerved leaves, and obtuse operculum."

Mr. T. W. Naylor Beckett, of Christchurch, says:—"The leaves are often nerveless, as in *Pilotrichella molle*, and I was unable to detect any nerve in the leaves of the specimen in Herb. Helms identified by Dr. Müller. The very robust habit, the turgid foliage, and the more obtuse and blunter ramuli form the most distinctive characters."—*Trans. N.Z. Inst.* 1893, p. 285.

Hab.—On trees, Macquarie Harbour, 1893, T. B. Moore, No. 9. Columba Falls, South George River, 1894, W.A.W., No. 1607.

(Also found in Victoria and New Zealand.)

38. *Hypnum* (*Rhynchostegium*) *convolutifolium*, Hampe, Linnæa 1859, p. 641.

Syn.—*Amblystegium convolutifolium* (Hampe), Mitt. Austral. mosses, p. 39. *Rhynchostegium strictiusculum*, Broth., in Bailey Cont. Queensland Fl. iv., p. 21 (name only).

Hab.—River Mersey, near Latrobe Waterworks, on trunk of tree, W.A.W., No. 1492.

(Also Victoria, F.v.M., and Queensland, F. M. Bailey.)

Mr. Brotherus says (New Sp. Austral. Mosses iii., p. 67) that having had an opportunity of examining original specimens of *H. convolutifolium*, Hampe, kept in Lindberg's herbarium, he finds it to be a genuine *Rhynchostegium*,, and the Queensland moss, *H. strictiusculum*, Broth., to be perfectly identical with it.

39. *Polytrichum (Pogonatum) australasicum*, Hampe and C. Müll., Linnæa, 1853, p. 500.

Very like *P. tortile*, Swartz. Dioicous. Leaves from a subvaginant base short, pellucid, lanceolate, somewhat obtuse, somewhat plane, towards the apex spinulose-serrulate, spinulose at back, areolation sublax; the comal leaves as the others; all when dry intensely green; nerve wide, and covered with numerous lamellæ almost to the apex of leaf. Capsule cylindric-oblong, subcernuous, fuscous, everywhere smooth; operculum conic-apiculate, obtuse, short.

"The Australasian plant seems to be quite distinct from Swartz's *P. tortile* of the West Indies, being distinguished by its more obtuse leaves, its comal leaves being of the same form as the others, and particularly by its smooth cylindric capsule."—T. W. Naylor Beckett in *Trans. N.Z.*, 1893, p. 285.

Hab.—On shady earth banks, St. Crispin's Track, Mount Wellington, 1888, and Castra-road, Leven, 1892, W.A.W., Nos. 843 and 1057.

(Also found in Australia and New Zealand).

40. *Sphagnum antarcticum*, Mitt., Journ. Linn. Soc. IV. p. 100.

Hab.—On wet roadside bank, Longley, Huon-road, 1889 and 1892, and on Snake Plains, Mt. Wellington, 1894, W.A.W., Nos. 202, 1142, and 1617.—At Long Bay, Channel, 1890, A. J. Taylor (Herb. W.A.W., No. 1376).

MOSSES PREVIOUSLY RECORDED, BUT WANTING DESCRIPTION.

Isopterygium acuminatum, Bosw., Journal of Botany, April, 1892. (Proc. Roy. Soc. Tasm., 1893, p. 204, name only.)

In loose, low, soft tufts, bright green and lutescent-green. Leaves distichously compressed, shining, ovate-lanceolate, elongate, piliform, acuminate, truncate at base, margins quite entire; nerve very short, scarcely apparent; cells narrow elongate, the basal dilated, sub-quadrate, yellow. Capsule oblong, horizontally inclined.

"A rather larger plant," adds Mr. Boswell, "than *I. tenerum* (Hypnum), Swartz, from the West Indies, the leaves rather wider, long and slenderly acuminate. Colour bright glossy-green and straw-yellow. The opercula have vanished; the peristome seems normal."

Sphagnum serrulatum, Warnst. Hedwigia 1893 Tab. I. f. 1a—1g. (Proc. Roy. Soc. Tasm. 1893, p. 204, name only).

Plant robust, dark-green (always ?), floating in water, resembling a strong *Sph. cuspidatum*, Ehrh., especially the variety *plumosum*, Nees.

Stem leaves large, isosceles-triangular, 1·37—1·50 mm. long, and at the base averaging 1·14 mm. wide, with a narrow rounded or truncate, toothed apex; both kinds of cells in the middle and lower parts, the hyaline narrow and tube-shaped, without fibres or pores, the apical cells usually only chlorophyllose, the marginal gradually narrower, and forming an unmarked-off border of equal width.

Branches usually four in a fascicle, two long, strong, pointed, loosely leaved, and two somewhat weaker, rigid. Leaves of the former very large, long, narrow lanceolate, 5—5·14 mm. long, and at the base 1·14 mm. wide, running out to a narrow, truncate, coarsely-toothed apex, the margins from below the middle upwards, especially towards the apex, almost spinosely toothed, not rolled up when dry, undulate, somewhat shining; hyaline cells absent, only thin-walled trapezoid or nearly quadrate green cells, full of chlorophyll granules, gradually narrower towards the margin until they form an unmarked-off border, of course without fibres or pores.

Hab.—In ditch, Zeehan Railway, West Coast, 1891, W.A.W., No. 622.

"This," says Mr. Warnstorf, "is a remarkable species of the cuspidate group, and is distinguished from all others known to me by the presence in the branch leaves of none but chlorophyllose cells, all trace of fibres or pores therefore being absent. With forms of *Sph. cuspidatum* living in water exclusively it frequently happens that the hyaline cells recede in favour of the green cells, but that they should be wholly wanting is probably a new biological phenomenon with *Sphagna*. Another peculiarity is that the borders of both stem and branch leaves are not marked off from the other cell structure."

Sphagnum pseudo-rufescens, Warnst., Hedwigia 1893, Tab. II. f. 5a—5l. (Proc. Roy. Soc. Tasm., 1893, p. 204, name only.)

Plant scarcely distinguishable in habit from a densely branched *Sph. rufescens* with reddish-brown comæ.

Stem weak; cuticular cells in 1—2 layers, wide, nearly quadratic, with thin walls; woody tissue yellowish or reddish. Stem leaves very large, tongue-shaped, 2·20 mm. long, and at the base 1 mm. wide, apex rounded and denticulate, the upper margins more or less rolled up (often on one side only), narrow border of equal width all round; the inner hyaline cells almost poreless, the outer with numerous pores in rows at the commissures, very fibrous, the fibre structure mostly interrupted above the base, but resumed in the basal cells.

Branch fascicles densely crowded. Branches 4-5 in a fascicle, 2—3 stronger, divergent, the rest weaker, pendent. Leaves large, ovate or ovate-lanceolate, 1·83—3·14 mm. long, and at the base 1—1·32 mm. wide, the apex somewhat truncate and coarsely toothed, the margins bordered by 3—4 layers of narrow cells and curled far downwards, when dry closely imbricate, rarely placed slightly towards one side, not shining Hyaline cells, narrow, long, very fibrous, nearly poreless on the inner leaf surface, but with numerous small pores at the commissures on the outer surface, the pores being much larger towards the base. Chlorophyllose cells in transverse section barrel-shaped, thick walled, central, free.

Hab.—In bog, top Mount Wellington, 1888, W.A.W., Nos. 972-7.

"By the pore structure in the branch leaves," says Mr. Warnstorf, "this species is very close to *Sph. subsecundum*, Nees; whilst the large stem leaves, fibrous to the base and bordered narrowly all round, reminds one of *Sph. rufescens* and *Sph. obesum*, Wils."

Sphagnum macrocephalum, Warnst., Hedwigia 1893, Tab. II. f. 6a—6g. (Proc. Roy. Soc. Tasm. 1893, p. 204, name only.)

Plant very robust, bluish-green or tinged with brown; the short upper branches uniting in a thick globular coma; in habit resembling a strong *Sph. cymbifolium*, especially the var. *glaucescens*.

Cuticle of the thick stem in 3—4 layers of wide cells without fibres, but those of the external layers with a large opening on the topside; the woody tissue dark red, with narrow thick-walled cells.

Stem leaves large, 1·28 mm. long and at the base 1·14 mm. wide, tongue shaped. Hyaline cells towards the margins and the apex divided by obliquely-running walls, and terminating (especially at the apex) in a wide hyaline border, in which, however, the walls appear to be absent; quite without fibres, but with large round pores in nearly all the cell-angles.

Branches usually five in a fascicle, two strong, divergent, the rest much weaker, softer, and shorter, and appressed to stem. Cuticular cells of both in one layer, only here and there a cell is divided lengthways. Leaves of divergent branches large, up to 2·14 mm. long, and below the middle about 1 mm. wide, from a narrow base widening to the middle, then gradually narrowing to a wide, truncate, toothed, cap-shaped apex, closely imbricate or squarrose, when dry faintly shining; margins denticulate and bordered by 3—4 layers of narrow cells. Hyaline cells very fibrose, those on the upper half of the inner suface of leaf having medium-sized pores, especially where several cell angles meet; nearer the margins the pores are solitary and small, whilst the base is poreless; on the apical half of the outer surface pores very numerous in rows at the commissures, slightly ringed, round to half-round, medium to small, in the basal part only small angle pores. Chlorophyllose cells in section elliptic, central, enclosed by the hyaline cells on the inner surface, but free on the outer, where the walls are mostly smaller, strong, and thickened. Leaves of the pendent branches appressed, lanceolate, with hyaline border towards apex; areolation much laxer; on both surfaces the hyaline cells have numerous much larger, delicately ringed, pores. Chlorophyllose cells trigonous-oval, nearer the outer surface, and here free, but enclosed at the inner surface by the hyaline cells.

Hab.—On the ground, Lake Bellinger Track, Zeehan Railway, West Coast, 1891, W.A.W., Nos. 623-4.

Bryum (*Eubryum*) *sullivani*, C Müll. Brotherus's Australian Mosses, ii., p. 37. (Proc. Roy. Soc. Tasm., 1893, p. 208, name only.)

Dioicous; in dense, soft, turgescent tufts, sordid green, scarcely shining. Stem to 2 cm. high, erect, densely leaved, sparingly radiculose at base; innovations few, erect, strict, to 8 mm. high, densely leaved, rather acute. Leaves all nearly equal, when dry imbricate, when wet patent, soft, very concave, not decurrent, oblong, somewhat obtuse, 1·5—1·7 mm. long and 0·5—0·6 mm. wide, not quite entire, not limbate, margins erect, revolute at base on one side only; nerve stout, 0·06 wide near the base, lutescent, red at base, vanishing below the apex; cells in the middle of the leaf rhomboid-hexagonal, 0·050—0·060 mm. long and 0·010—0·015 mm. wide, the basil rectangular, the lowest inflated, purple. Perichaetial bracts ovate, acuminate, the innermost smaller, from a dilated base gradually acuminate. Seta to 13 mm. high, geniculate-ascending at base, cygneous at apex, thin, purple, not shining, not twisted when dry. Capsule pendulous, oblong, with short thick neck, when dry rugose, 2·25 mm. long and 1 mm. thick, symmetrical, not constricted below the mouth, purple, not shining; annulus broad, revolute; peristome as in *Br. alpinum*, spores 0·012—0·015 mm., ochraceous, quite smooth; operculum convex-conic, acutely apiculate, pallid. Male plant unknown.

"Related," says Mr. Brotherus, "to *Br. alpinum* and *Br. muehlenbeckii*. It recedes from the former in the much laxer areolation of the leaves and the vanishing nerve; and is distinguished from the latter by the purple capsule with thick neck."

ABBREVIATIONS.

Broth.—Professor V. F. Brotherus, of Helsingfors, Finland.

Burch.—Dr. O. Burchard, of Hamburg.

Geh.—Mr. A. Geheeb, who is working with Professor Brotherus on Baron Sir F. von Mueller's mosses.

Mitt.—Mr. W. Mitten, of Hurstpierpoint, Sussex, England.

Vent.—Dr. G. Venturi, of Trento.

Warnst.—Mr. C. Warnstorf, of Neuruppin, Prussia.

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